



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.03.2011 Bulletin 2011/11

(51) Int Cl.:
F02B 77/08 (2006.01) **F01N 11/00** (2006.01)
F02F 1/42 (2006.01)

(21) Application number: **10173564.5**

(22) Date of filing: **20.08.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
BA ME RS

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(30) Priority: **21.08.2009 JP 2009192352**
30.07.2010 JP 2010173163

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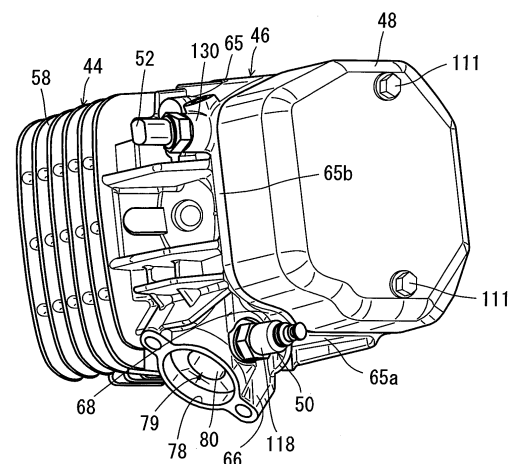
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(54) **Engine and saddle-riding type vehicle including the same**

(57) There is provided an engine in which a projection of the oxygen concentration sensor outwardly of the cylinder head can be prevented and engine size increase is reduced even if the oxygen concentration sensor is provided at a position at which the exhaust gas has a high temperature in the cylinder head. Also, there is provided a saddle-riding type vehicle which includes the engine. An engine 36 includes: a cylinder head 46 which has a projected portion 66 projecting outwardly from a head main body 65; a combustion recess 70 formed in the head main body 65; an exhaust gas passage 80 from the combustion recess 70 through the projected portion 66 for discharging exhaust gas from the combustion recess 70; and an oxygen concentration sensor 50 which has a main body portion 118 and a detection portion 120. The oxygen concentration sensor 50 is mounted to the projected portion 66. The main body portion 118 and the detection portion 120 overlap the projected portion 66 when viewed from the direction of a cylinder axis A. Further, at least part of the detection portion 120 is located within the exhaust gas passage 80.

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Description

[FIELD OF THE INVENTION]

[0001] The present invention relates to an engine and a saddle-riding type vehicle which includes the engine. More specifically, the present invention relates to an engine which has an oxygen concentration sensor for detecting an oxygen concentration in exhaust gas; and to a saddle-riding type vehicle which includes the engine.

[BACKGROUND ART]

[0002] As a conventional technique of this category, a single-cylinder engine is proposed in Patent Document 1 for example.

[0003] Referring to Fig. 19 (a) and Fig. 19 (b) , the single-cylinder engine disclosed in Patent Document 1 has a cylinder head 1a, which has a raised portion 2a on its outer circumferential surface. An exhaust gas passage 3a is formed, penetrating the raised portion 2a. With this arrangement, an oxygen concentration sensor 4a for detecting an oxygen concentration in exhaust gas is mounted on the raised portion 2a, between a cylinder head cover mounting flange 5a of the cylinder head 1a and the raised portion 2a of the cylinder head 1a, obliquely to an engine cylinder axis. Also, the oxygen concentration sensor 4a mounted on the raised portion 2a has its detection portion located within the exhaust gas passage 3a. The oxygen concentration sensor 4a as the above is heated by high-temperature exhaust gas in the exhaust gas passage 3a, and is heated quickly to an activation temperature of the sensor. Therefore, it is possible to implement a heaterless oxygen concentration sensor.

[0004] Another conventional example is disclosed in Patent Document 2.

[0005] Referring to Fig. 20, Patent Document 2 discloses a single-cylinder engine which has a space 2b for a timing chain to drive a cam shaft on a left side of a cylinder head 1b as viewed from front on a cylinder axis. The cylinder head 1b has a lower portion formed with a rightward-slanting exhaust gas port 3b. With this arrangement, an oxygen concentration sensor 4b for detecting an oxygen concentration in exhaust gas is mounted to the cylinder head 1b so that the detection portion of the concentration sensor 4b is within the exhaust gas port 3b. In this single-cylinder engine, too, the oxygen concentration sensor 4b is heated by high-temperature exhaust gas which passes through the exhaust gas port 3b, and is heated quickly to an activation temperature of the sensor. Therefore, it is possible to implement a heaterless oxygen concentration sensor.

[0006] It should be noted here that in Fig. 19 and Fig. 20, a crankshaft direction is defined as a left-right direction, a cylinder axis direction is defined as a fore-aft direction, and a direction perpendicular to both of the crankshaft direction and the cylinder axis direction is defined as an up-down direction.

[DOCUMENTS ON CONVENTIONAL ART]

[Patent Document]

[0007]

[Patent Document 1] Japanese Patent No. 4152796

[Patent Document 2] Japanese Patent Laid-Open No. 2006-183489

[SUMMARY OF THE INVENTION]

[Problems to be Solved by the Invention]

[0008] A primary object of the present invention is to provide an engine in which a projection of the oxygen concentration sensor outwardly of the cylinder head can be prevented and engine size increase is reduced even if the oxygen concentration sensor is provided at a position at which the exhaust gas has a high temperature in the cylinder head. Another object of the present invention is to provide a saddle-riding type vehicle which includes the engine.

[Means for Solving the Problems]

[0009] According to an aspect of the present invention, there is provided a single-cylinder or V-twin-cylinder engine, which includes: a cylinder head having a head main body and a projected portion projecting outwardly from the head main body; a combustion recess formed in the head main body; an exhaust gas passage from the combustion recess through the projected portion for discharging exhaust gas from the combustion recess; and an oxygen concentration

sensor having a main body portion and a detection portion provided in the main body portion, for detecting an oxygen concentration in the exhaust gas. With this arrangement, the oxygen concentration sensor is mounted to the projected portion, with the main body portion and the detection portion overlapping the projected portion as viewed from a direction of the cylinder axis. Further, at least part of the detection portion is located within the exhaust gas passage.

[0010] In the present invention, the cylinder head has a head main body and a projected portion which projects outwardly from the head main body. The exhaust gas passage is formed to penetrate the projected portion. With this arrangement, the oxygen concentration sensor is mounted to the projected portion. The main body portion and the detection portion overlap the projected portion when viewed from the direction of the cylinder axis. Further, at least part of the detection portion is located within the exhaust gas passage. The arrangement prevents the oxygen concentration sensor from projecting outward beyond the cylinder head even if the oxygen concentration sensor is mounted to a position where exhaust gas temperature is high. Therefore, the arrangement makes it possible to reduce size increase in the single-cylinder engine or the V-twin-cylinder engine without sacrificing their traditional characteristic that it is compact in the left-right direction. It should be noted here that although the cylinder head projects outward by as much as the projected portion, the arrangement allows the exhaust apparatus which is mounted to the cylinder head to be shortened by as much, so there is no size increase in the outer structure of the engine.

[0011] Preferably, the oxygen concentration sensor as mounted to the projected portion has the main body portion located at a more forward position than the detection portion. In this case, it is possible to prevent the main body portion from interfering with the air-cooling fins of the cylinder body and/or a crankcase, and to mount the oxygen concentration sensor easily to the cylinder head without projecting in the left-right direction.

[0012] Further preferably, the oxygen concentration sensor as mounted to the projected portion has a center axis parallel to the cylinder axis. In this case, it is easy to prevent the oxygen concentration sensor from projecting outwardly of the cylinder head.

[0013] Further, preferably, the projected portion projects from the head main body at least in a downward direction. In this case, the arrangement allows effective use of the space below the head main body, for the projected portion.

[0014] Preferably, the projected portion projects from the head main body in an obliquely downward direction when viewed from the direction of the cylinder axis. In this case, the arrangement makes it possible to form the cylinder head compactly while ensuring a sufficient length of the projected portion.

[0015] Further preferably, the oxygen concentration sensor does not project beyond the head main body in a left-right direction when viewed from the direction of the cylinder axis. In this case, the arrangement prevents the oxygen concentration sensor more reliably, from projecting outwardly of the cylinder head, making it possible to further reduce the size increase in the engine.

[0016] Further, preferably, the projected portion has an opening portion as a downstream end of the exhaust gas passage, and a center of the opening portion is not on a more outer side than the head main body in a left-right direction when viewed from the direction of the cylinder axis. In this case, the arrangement reduces projection of the projected portion outwardly of the cylinder head, making it possible to further reduce the size increase in the engine.

[0017] Preferably, the head main body has an outer circumferential surface with a recess recessing inwardly of the head main body as viewed from the direction of the cylinder axis, and the projected portion is formed in the recess. In this case, the arrangement allows mounting of the oxygen concentration sensor to the projected portion closely to the recess, making it possible to reduce projection of the projected portion outwardly of the cylinder head. Therefore, the cylinder head can be made compactly.

[0018] Further preferably, the recess recesses upwardly. In this case, the arrangement makes it possible to form the cylinder head compactly while ensuring a sufficient length of the projected portion which is provided in the recess.

[0019] Further preferably, the recess recesses sideways. In this case, the arrangement makes it possible to form the cylinder head compactly while ensuring a sufficient length of the projected portion which is provided in the recess.

[0020] Preferably, the recess is formed as a recessed corner portion of the head main body. In this case, the arrangement makes it possible to form the cylinder head compactly while ensuring a sufficient length of the projected portion which is provided in the recess.

[0021] Further preferably, the engine further includes a cylinder head cover provided ahead of the cylinder head; and a sensor cover portion provided in the cylinder head cover for covering at least a front portion of the main body portion.

In this case, it is possible to cover the front and rear of the oxygen concentration sensor with the projected portion and the sensor cover portion. Therefore, a saddle-riding type vehicle mounted with the engine can protect the oxygen concentration sensor appropriately, from bouncing stones, etc. from the road surface. Since the oxygen concentration sensor mounted to the projected portion overlaps the projected portion when viewed from the direction of the cylinder axis, and is located near the cylinder head, the sensor cover portion is not increased in size.

[0022] Further, preferably, the engine further includes a cylinder head cover provided ahead of the cylinder head; the cylinder head has a cover mounting surface for mounting the cylinder head cover; the projected portion has a sensor mounting surface for mounting the oxygen concentration sensor; and the cover mounting surface and the sensor mounting surface are parallel to each other. In this case, the arrangement makes it easy to form the cover mounting surface and

the sensor mounting surface by machining.

[0023] Preferably, the engine further includes a cylinder head cover provided ahead of the cylinder head; the cylinder head has a cover mounting surface for mounting the cylinder head cover; the projected portion has a sensor mounting surface for mounting the oxygen concentration sensor; and the cover mounting surface and the sensor mounting surface are in a same plane. In this case, the arrangement allows simultaneous machining of the cover mounting surface and the sensor mounting surface, making it even easier to obtain the cylinder head.

[0024] Further preferably, the engine further includes a cylinder head cover provided ahead of the cylinder head; and an electric wire connected with the main body portion and routed along the cylinder head cover. In this case, the arrangement makes it possible to route the electric wire away from the exhaust gas passage that is formed in the cylinder head. Therefore, detrimental effect of exhaust gas heat from the exhaust gas passage to the electric wire is reduced. The arrangement reduces deterioration of the electric wire. Also, routing the electric wire along the cylinder head cover provides an advantage of reduced space necessary for the electric wire which is drawn out of the engine.

[0025] Further, preferably, the engine includes a holding portion provided in the cylinder head cover for holding the electric wire. In this case, the arrangement makes wire routing easy since the holding portion makes it easy to route the electric wire along the cylinder head cover.

[0026] According to the engine offered by the present invention, it is possible to prevent the oxygen concentration sensor from projecting outwardly of the cylinder head, and therefore to reduce size increase in the engine. Thus, application of the engine according to the present invention to a saddle-riding type vehicle such as a motorcycle helps reducing size increase of the saddle-riding type vehicle.

[0027] Preferably, the cylinder axis is slanted in an obliquely forward and upward direction. In this case, the arrangement reduces projection of the engine in a downward direction. Therefore, such a configuration can be utilized suitably to a saddle-riding type vehicle which includes a single-cylinder or a V-twin-cylinder engine.

[0028] In the present invention, the word "outward" used with respect to the cylinder head refers to all radial directions which are perpendicular to the cylinder axis, including not only laterally outward (left-right) directions but also upwardly/downwardly outward directions.

[0029] Also, the expression that the "main body portion and the detection portion overlap the projected portion as viewed from a direction of the cylinder axis" means that neither the main body portion nor the detection portion are out of the outline of the projected portion when viewed from a cylinder axis direction.

[0030] The above-described object and other objects, characteristics, aspects and advantages of the present invention will become clearer from the following detailed description of embodiments of the present invention with reference to the attached drawings.

[Advantages of the Invention]

[0031] According to the present invention, a projection of the oxygen concentration sensor outwardly of the cylinder head can be prevented and the engine size increase can be reduced even if the oxygen concentration sensor is provided at a position where the exhaust gas has a high temperature in the cylinder head.

[0032] Thus, problems associated with conventional techniques can be avoided. To be more specific, the oxygen concentration sensor 4a in Patent Document 1 does not interfere with a boss portion 6a which is used to connect the cylinder head 1a with the cylinder body, nor with a cylinder head cover which is provided in front of the cylinder head 1a. However, as shown in Fig. 19(b), although the oxygen concentration sensor 4a does not interfere with the flange 5a, the oxygen concentration sensor 4a has its end portion projecting to the left of the cylinder head 1a.

[0033] In Patent Document 2, the oxygen concentration sensor 4b extends rightward from a right-side portion of the exhaust gas port 3b, and does not interfere with a left-side portion of the cylinder head 1b or the cylinder head cover. However, when the cylinder head 1b is viewed from the cylinder axis direction, the oxygen concentration sensor 4b has its end portion (a right-hand end portion in Fig. 20) projecting largely to the right of the cylinder head 1b.

[0034] As described, in whichever of the engines offered in Patent Documents 1 and 2, the oxygen concentration sensor projects to the left or right of the cylinder head, adding extra dimensions to the engine. This is especially disadvantageous in single-cylinder engines and V-twin-cylinder engines because their traditional advantage that they can be compact in a left-right direction is lost.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0035]

Fig. 1 is a left side view of a motorcycle according to an embodiment of the present invention.

Fig 2 is a left side view of a power unit, a rear wheel and their adjacent region.

Fig 3 is a drawing when a motorcycle frame, the power unit, the rear wheel and their adjacent region are viewed

from front, on a cylinder axis.

Fig 4 is a drawing when an engine according to an embodiment of the present invention is viewed from front, on a cylinder axis.

Fig 5 is a right side view of a primary portion of the engine.

Fig 6 is a perspective view of a primary portion of the engine.

Fig 7 is a drawing of a partial section taken in lines I-I in Fig. 4.

Fig 8 is a sectional view taken in lines II-II in Fig. 5.

Fig 9 is a drawing when an engine according to another embodiment of the present invention is viewed from front, on a cylinder axis.

Fig 10 is a partially unillustrated right side view, showing an example of an engine mounted with an air shroud.

Fig 11 (a) is a drawing of a primary portion and an adjacent region of an example of a cylinder head cover, formed with a sensor cover portion as viewed from front, on a cylinder axis; and Fig. 11(b) is a perspective view thereof.

Fig 12 (a) is a drawing of a primary portion and an adjacent region of another example of cylinder head cover formed with a sensor cover portion as viewed from front, on a cylinder axis; and Fig. 12(b) is a perspective view thereof.

Fig 13 is a drawing with a partial section, showing an engine according to still another embodiment of the present invention.

Fig 14 is a drawing when an engine according to another embodiment of the present invention is viewed from front, on a cylinder axis.

Fig 15 is a drawing of a primary portion, showing an oxygen concentration sensor mounted on a projected portion at a slant.

Fig 16 is a drawing of a section taken in lines III-III in Fig. 15.

Fig 17(a) is a drawing when a V-twin-cylinder engine according to an embodiment of the present invention is viewed from a side; and Fig. 17 (b) is a drawing when the engine is viewed from above.

Fig 18 is a left side view of a motorcycle according to another embodiment of the present invention.

Fig 19 (a) and Fig. 19 (b) are perspective views of a cylinder head according to Patent Document 1.

Fig 20 is a sectional view of a cylinder head according to Patent Document 2.

[MODES OF EMBODYING THE INVENTION]

[0036] Hereinafter, embodiments of the present invention will be described with reference to the drawings.

[0037] It should be noted here that when describing engines according to the present invention, a crankshaft direction is defined as a left-right direction, a cylinder axis direction is defined as a fore-aft direction, and a direction perpendicular to both of the crankshaft direction and the cylinder axis direction is defined as an up-down direction. When describing motorcycles according to the embodiments of the present invention, a left-right direction, a fore-aft direction, and an up-down direction are defined from the motorcycle rider's position on a seat of a motorcycle, with the rider facing toward a handlebar. In the figures, a cross-shaped arrow mark indicates directions: an "F" arrow indicates forward, "Rr" indicates rearward, "U" indicates upward, "Lo" indicates downward, "R" indicates rightward, and "L" indicates leftward.

[0038] Fig. 1 is a left side view of a so-called scooter-type motorcycle 10 which includes an engine 36 according to an embodiment of the present invention.

[0039] Referring to Fig. 1, the motorcycle 10 includes a motorcycle frame 12. In a front portion of the motorcycle frame 12, there is a handlebar 14 provided at an upper position, and there is a front wheel 16 provided at a lower position. At a rear position above the motorcycle frame 12, a seat 18 is provided for the motorcycle rider to ride on. Between the handlebar 14 and the seat, along the motorcycle frame 12, a footrest 20 is provided for the rider to rest his/her feet. The footrest 20 has a portion for the right foot and a portion for the left foot for the rider on the seat 18, and these two portions are continuous at the same level. This arrangement provides a large space available above the footrest 20, between the handlebar 14 and the seat 18. The motorcycle frame 12 is provided so as to pass below the footrest 20.

[0040] The motorcycle frame 12 includes a pair of frames 22 disposed in a left-right direction at a space therebetween, (see Fig. 3). The frames 22 are spaced by a predetermined distance in the left-right direction, extending in an obliquely rearward and upward direction. The pair of frames 22 support a power unit 26 pivotably in an up-down direction via a link mechanism 24.

[0041] The link mechanism 24 has a pivot shaft 28 which connects the pair of frames 22, and a link member 30 which connects the pivot shaft 28 and the power unit 26 with each other and is pivotable in the up-down direction around the pivot shaft 28.

[0042] The power unit 26 is below the seat. The power unit 26 has its rear portion connected with the frames 22 by a rear cushion unit 32. The power unit 26 has a rear end portion provided with a rear wheel 34.

[0043] Fig. 2 is a left side view of the power unit 26, the rear wheel 34 and their adjacent region. Fig. 3 is a drawing when the motorcycle frame 12, the power unit 26, the rear wheel 34 and their adjacent region are viewed from front, on a cylinder axis A.

[0044] The power unit 26 includes an engine 36 which is of an air-cooled, single-cylinder type for example; and a transmission case 38 which incorporates power-transmission equipment (not illustrated) including a transmission, a speed reducer and so on.

[0045] In a side view of the motorcycle 10, the engine 36 is across the frame 22. The engine 36 has a crankshaft 40, a crankcase 42, a cylinder body 44, a cylinder head 46 and a cylinder head cover 48. The crankcase 42, the cylinder body 44, the cylinder head 46 and the cylinder head cover 48 are on a cylinder axis A of the engine 36, in this order from rear to front, in the fore-aft direction of the motorcycle. The crankcase 42, the cylinder body 44, the cylinder head 46 and the cylinder head cover 48 are connected with their adjacent members. As shown in Fig. 1 and Fig. 2, the cylinder axis A is slanted in an obliquely forward and upward direction with respect to the fore-aft direction of the motorcycle. In this embodiment, the axis A is slanted slightly.

[0046] The crankcase 42 rotatably supports the crankshaft 40 which extends in the left-right direction. As shown in Fig. 3, the crankcase 42 has its right portion located behind the frames 22. Also, the cylinder body 44, the cylinder head 46 and the cylinder head cover 48 are located between the left-and-right pair of frames 22 when viewed from the direction of the cylinder axis A so that the power unit 26 is pivotable in the up-down direction without interfering with the frames 22.

[0047] The transmission case 38 is behind the frames 22, on the left of the crankcase 42. The transmission case 38 has a rear end portion, to which a rear wheel 34 is mounted rotatably. The rear wheel 34 is behind the engine 36, disposed side by side to the transmission case 38 in the motorcycle's width direction. Power from the engine 36 is transmitted to the rear wheel 34 via the power-transmission equipment.

[0048] As will be described later, the cylinder head 46 is provided with an oxygen concentration sensor 50 for detecting an oxygen concentration in exhaust gas discharged from a combustion chamber 90 (a combustion recess 70 in the cylinder head 46) of the engine 36; and an oil temperature sensor 52 for detecting a temperature of engine oil flowing in the engine 36. Also, the cylinder head 46 has an upper surface connected with an air intake apparatus 54 for supplying air to the combustion chamber 90 via an air intake passage 74 of the engine 36. The cylinder head 46 has a lower portion connected with an exhaust apparatus 56 for discharging exhaust gas from the combustion chamber 90 of the engine 36 via an exhaust gas passage 80.

[0049] Referring to Fig. 4 through Fig. 8, the engine 36 will be detailed.

[0050] Fig. 4 is a drawing of the engine 36 as viewed from front, on the cylinder axis A. Fig. 5 is a right side view of a primary portion of the engine 36. Fig. 6 is a perspective view of a primary portion of the engine 36. Fig. 7 is a drawing of a partial section taken in lines I-I in Fig. 4. Fig. 8 is a sectional view taken in lines II-II in Fig. 5.

[0051] The cylinder body 44 has air-cooling fins 58 on its outer side surfaces, and has a cylindrical cylinder bore 60 which extends in the direction of the cylinder axis A in its inside. Inside the cylinder bore 60, a piston 62 is reciprocable. The piston 62 is connected with the crankshaft 40 via a connecting rod 64. It should be noted here that the cylinder axis A is a longitudinal center axis of the cylinder bore 60.

[0052] The cylinder head 46 has a head main body 65 and a projected portion 66. The projected portion 66 is in an outer circumferential surface of the head main body 65, projecting outwardly of the head main body 65. Referring to Fig. 4 and Fig. 6, the outer circumferential surface of the head main body 65 has a curved recess 68 recessing inwardly of the head main body 65 as viewed from the direction of the cylinder axis A. Specifically, the recess 68 recesses upward, to a higher level than a lower surface 65a of the head main body 65. Also, the recess 68 recesses sideways (to a more leftward position than a right-hand surface 65b of the head main body 65, in the present embodiment). Further, the recess 68 is formed as a recessed corner portion of the head main body 65. In other words, the recess 68 extends in the direction of the cylinder axis A in the outer circumferential surface of the head main body 65.

[0053] The projected portion 66 is provided in the recess 68 when viewed from front in the direction of the cylinder axis A. When viewed from front in the direction of the cylinder axis A, the projected portion 66 projects from the head main body 65 in an obliquely rightward and downward direction. It should be noted here that the oxygen concentration sensor 50 does not project in the left-right direction beyond the head main body 65 when viewed from the direction of the cylinder axis A.

[0054] As shown in Fig. 7, the head main body 65, which is included in the cylinder head 46, has a rear end portion formed with the combustion recess 70. The combustion recess 70 and the opening portion 72 in the upper surface of the cylinder head 46 communicate with each other via the air intake passage 74. An opening of the air intake passage 74 in a surface of the combustion recess 70 represents an air intake port 76. The air intake apparatus 54 is connected with the opening portion 72. The combustion recess 70 communicates with an opening portion 78 of the projected portion 66 via the exhaust gas passage 80. An opening of the exhaust gas passage 80 in a surface of the combustion recess 70 represents an exhaust gas port 82. The opening portion 78 in the projected portion 66 is connected with the exhaust apparatus 56. The exhaust apparatus 56 has a flange portion 84 at its end portion, and the flange portion 84 is mounted onto the projected portion 66 with stud bolts 86 and nuts 88.

[0055] Referring to Fig. 4, when the engine 36 is viewed from front, in the direction of the cylinder axis A, the exhaust gas passage 80 in the cylinder head 46 extends at a downward slant with respect to the up-down direction (a direction perpendicular to both the crankshaft 40 and the cylinder axis A). More specifically, when the engine 36 is viewed from

front, in the direction of the cylinder axis A, the exhaust gas passage 80, which is formed in the cylinder head 46, extends in an obliquely rightward and downward direction from the combustion chamber 90 (the combustion recess 70) and the exhaust gas port 82. Also, the opening portion 78 of the projected portion 66, which represents the downstream end of the exhaust gas passage 80, is slanted with respect to the up-down direction. More specifically, the opening portion 78 of the projected portion 66, which represents the downstream end of the exhaust gas passage 80, is oriented in an obliquely rightward and downward direction. Further, the opening portion 78 has a center 79, which is not on a more outer side than the head main body 65 in the left-right direction when viewed from the direction of the cylinder axis A. As described, the exhaust gas passage 80 is formed also in the projected portion 66. The exhaust gas passage 80 extends away from a transmission member 98 and a rotation member 100 (to be described later) which are provided on the left side within the engine 36. It should be noted here that the combustion chamber 90 is a space provided by the cylinder bore 60, the piston 62 and the combustion recess 70.

[0056] In the engine 36, air passes through the air intake apparatus 54 and the air intake passage 74, and reaches the combustion chamber 90. Exhaust gas from the combustion chamber 90 goes through the exhaust gas passage 80 and the exhaust apparatus 56 and then to the outside.

[0057] Referring to Fig. 7, the engine 36 further includes a valve driving apparatus 92, an air intake valve 94 and an exhaust valve 96.

[0058] The valve driving apparatus 92 includes the transmission member 98, the rotation member 100, a cam shaft 102, a cam 104 and arm members 106, 108. The transmission member 98 includes a metal chain for example, and connects the crankshaft 40 and the rotation member 100 with each other for transmitting rotation of the crankshaft 40 to the rotation member 100. The rotation member 100 is provided by a sprocket for example, and is rotated by the transmission member 98. The rotation member 100 rotates the cam shaft 102. The cam shaft 102 is provided with the cam 104, which pivots the arm members 106, 108. The arm member 106 drives the air intake valve 94, which opens and closes the air intake port 76 whereas the arm member 108 drives the exhaust valve 96, which opens and closes the exhaust gas port 82.

[0059] The cylinder head 46 has a cover mounting surface 110, to which the cylinder head cover 48 is mounted. As shown in Fig. 4 through Fig. 6, a plurality (two in the present embodiment) of fasteners 111 such as bolts are inserted from a front surface of the cylinder head cover 48 to fix the cylinder head cover 48 to the cylinder head 46. By mounting the cylinder head cover 48 to the cover mounting surface 110 as described above, the arrangement eliminates the need for a flange which is otherwise necessary to mount the cylinder head cover to the cylinder head 46. Therefore, the oxygen concentration sensor 50 can be extended in the direction of the cylinder axis A. The fasteners 111 may be provided by ordinary fastening members such as stud bolts and nuts, rivets, etc.

[0060] The projected portion 66 has a sensor mounting surface 112, and the oxygen concentration sensor 50 is mounted to the sensor mounting surface 112.

[0061] The cover mounting surface 110 and the sensor mounting surface 112 are parallel to each other.

[0062] Now, attention should be paid here to an arrangement that the oxygen concentration sensor 50, which is to detect an oxygen concentration in the exhaust gas that passes through the exhaust gas passage 80 and is mounted to the sensor mounting surface 112 of the projected portion 66, overlaps the projected portion 66 of the cylinder head 46 when viewed from the direction of the cylinder axis A. The expression that the "oxygen concentration sensor 50 overlaps the projected portion 66 when viewed from the direction of the cylinder axis A" means that the oxygen concentration sensor 50 is not out of the outline of the projected portion 66 when viewed from the direction of the cylinder axis A. As will be described later, a center axis B of the oxygen concentration sensor 50 may be parallel to the cylinder axis A, or may be slanted to the cylinder axis A.

[0063] The sensor mounting surface 112 is formed with a mounting hole 114, which communicates with the exhaust gas passage 80 and is parallel to the cylinder axis A. The mounting hole 114 has a female threaded portion 116.

[0064] The oxygen concentration sensor 50 includes a columnar main body portion 118 and a circularly columnar detection portion 120 provided coaxially with the main body portion 114 at an end of the main body portion 114. The oxygen concentration sensor 50 is columnar, and its axial length is greater than its radius. The main body portion 118 has a male threaded portion 122. In the present embodiment, the main body portion 118 has different diameters depending on its axial positions.

[0065] When the oxygen concentration sensor 50 is mounted to the projected portion 66 by threading the male threaded portion 122 into the female threaded portion 116, the detection portion 120 is inserted into the mounting hole 114 and exposed to the exhaust gas passage 80. As the oxygen concentration sensor 50 is mounted to the projected portion 66, the main body portion 118 and the detection portion 120 overlap the projected portion 66 of the cylinder head 46 when viewed from the direction of the cylinder axis A. Also, as mounted to the projected portion 66, the oxygen concentration sensor 50 is along the recess 68. In other words, the columnar oxygen concentration sensor 50 is provided in the direction in which the recess 68 extends. Once the oxygen concentration sensor 50 is mounted, the center axis B of the oxygen concentration sensor 50 and the cylinder axis A are parallel to each other, and at least part of the detection portion 120 is located within the exhaust gas passage 80.

[0066] The main body portion 118 has another end portion connected with a connector 125 of an electric wire 124. In the present embodiment, the electric wire 124 is detachable from and attachable to the main body portion 118. The detection portion 120 of the oxygen concentration sensor 50 contains stabilized zirconium for example, and becomes ready for accurate detection at a temperature not lower than a predetermined sensor activation temperature. Since at least part of the detection portion 120 is located within the exhaust gas passage 80 where high-temperature exhaust gas is passing through, the detection portion 120 is heated by the exhaust gas. Thus, the oxygen concentration sensor 50 quickly attains its sensor activation temperature. Therefore, the oxygen concentration sensor 50 is provided by a heaterless sensor which does not need any separate heating means for heating the detection portion 120, so, the oxygen concentration sensor 50 is be small and inexpensive.

[0067] Detection signals from the oxygen concentration sensor 50 are sent to the engine controller 126 via the electric wire 124. Based on the detection signals received, the engine controller 126 controls air-fuel ratio of the fuel supplied to the combustion chamber 90 to an optimum level. Specifically, the engine controller 126 drives a fuel injection valve 128 provided in the air intake apparatus 54, whereby fuel is injected into the air supplied to the combustion chamber 90.

[0068] Also, as shown in Fig. 4, Fig. 6 and Fig. 8, the cylinder head 46 has a boss portion 130 for mounting the oil temperature sensor in a side surface of the cylinder head 46. The boss portion 130 is formed in an upper region in a right side surface of the cylinder head 46. The boss portion 130 has a boss hole 132, which communicates with an oil passage 134 formed inside the cylinder head 46. The oil passage 134 is parallel to the cylinder axis A. Also inside the cylinder head 46, a bearing 136 is formed for the cam shaft 102. The bearing 136 and the boss hole 132 communicate with each other via the oil passage 138. The oil temperature sensor 52 is mounted to the boss portion 130 which has such an arrangement as described.

[0069] As the crankshaft 40 supported by the crankcase 42 rotates, an oil pump is driven via an idler gear inside the crankcase 42. This supplies oil from the oil pump, through an oil passage formed in the crankcase 42, an oil passage formed in a contact surface between the crankcase 42 and the cylinder body 44, an oil passage formed in the cylinder body 44 and the oil passage 134 formed in the cylinder head 46, and then to the cam shaft 102 and the valve driving apparatus 92. Oil from the oil pump is also supplied to the crankshaft 40 and an oil cooler. As described, oil is constantly and forcefully supplied from the oil pump to the lines connected directly thereto as long as the crankshaft 40 is rotating.

[0070] The oil temperature sensor 52 is positioned closely to the combustion chamber 90, where there is a constant flow of oil while the crankshaft 40 is rotating. Therefore, it is possible to detect a temperature of the combustion chamber 90, i.e., a temperature of the engine 36, accurately with the oil temperature sensor 52 while the crankshaft 40 is rotating. Values detected by the oil temperature sensor 52 are utilized in setting and correcting the amount of fuel injection.

[0071] According to the motorcycle 10 which includes the engine 36 as described, the cylinder head 46 has its projected portion 66 in an obliquely rightward and downward surface of an outer circumferential surface of the head main body 65, and the exhaust gas passage 80 extends from the combustion chamber 90 in an obliquely rightward and downward direction to penetrate the projected portion 66. The opening portion 78 at the downstream end of the projected portion 66 is oriented in an obliquely rightward and downward direction. With this arrangement, the main body portion 118 and the detection portion 120 of the oxygen concentration sensor 50 overlap the projected portion 66 when viewed from the direction of the cylinder axis A, and at least part of the detection portion 120 is located within the exhaust gas passage 80, once the oxygen concentration sensor 50 is mounted to the projected portion 66.

[0072] These arrangements prevent the oxygen concentration sensor 50 from projecting to a more outward position (especially in the left-right direction) than the cylinder head 46 even if the oxygen concentration sensor 50 is mounted to the projected portion 66 of the cylinder head 46 where exhaust gas temperature is high. Therefore, the single-cylinder engine 36 does not lose its characteristic that it is compact in the left-right direction. The arrangements make it possible to reduce size increase in the single-cylinder engine 36. The oxygen concentration sensor 50 does not project beyond the cylinder head cover 48 in the forward direction. The arrangements, therefore, also prevent the oxygen concentration sensor 50 from projecting in the fore-aft directions of the engine 36. Further, in the engine 36, the valve driving apparatus 92 has its forward end portion located farther ahead than the exhaust gas passage 80. As a result, there is a sufficiently long distance from the sensor mounting surface 112 of the projected portion 66 to the front surface of the cylinder head cover 48 in the direction of the cylinder axis A. More specifically, the distance from the sensor mounting surface 112 of the projected portion 66 to the front surface of the cylinder head cover 48 in the direction of the cylinder axis A is longer than a portion of the oxygen concentration sensor 50 exposed from the sensor mounting surface 112. Therefore, the electric wire 124 connected with the oxygen concentration sensor 50 does not project excessively ahead of the engine 36. The arrangement can reduce space necessary for routing the electric wire 124. It should be noted here that although the cylinder head 46 projects outward by as much as the projected portion 66, the arrangement allows the exhaust apparatus 56 which is mounted to the cylinder head 46 to be shortened by as much, so there is no size increase in the outer structure of the engine.

[0073] Especially, in the engine 36 according to the present embodiment, the distance from the sensor mounting surface 112 of the projected portion 66 to the front surface of the cylinder head cover 48 in the direction of the cylinder axis A is sufficiently long, and the oxygen concentration sensor 50 is columnar, with its axial length being greater than

its radius. In such an arrangement, it is easy to dispose the oxygen concentration sensor 50 in the cylinder head 46 so as to overlap the projected portion 66 when viewed from the direction of the cylinder axis A, and the present invention is particularly advantageous.

[0074] Once the oxygen concentration sensor 50 is mounted to the projected portion 66, the main body portion 118 is located at a more forward position than the detection portion 120. Therefore, it is possible to prevent the main body portion 118 from interfering with the air-cooling fins 58 of the cylinder body 44 and/or the crankcase 42, making it possible to mount the oxygen concentration sensor 50 easily to the cylinder head 46 without projecting in the left-right direction.

[0075] As mounted to the cylinder head 46, the center axis B of the oxygen concentration sensor 50 is parallel to the cylinder axis A. The arrangement makes it easy to prevent the oxygen concentration sensor 50 from projecting in the left-right direction and the downward direction.

[0076] The projected portion 66 projects from the head main body 65 at least in a downward direction. The arrangement allows effective use of the space below the head main body 65, for the projected portion 66.

[0077] The projected portion 66 projects in an obliquely downward direction from the head main body 65 when viewed from the direction of the cylinder axis A. The arrangement makes it possible to form the cylinder head 46 compactly while ensuring a sufficient length of the projected portion 66.

[0078] The oxygen concentration sensor 50 does not project in the left-right direction beyond the head main body 65 when viewed from the direction of the cylinder axis A. The arrangement prevents the oxygen concentration sensor 50 more reliably, from projecting outwardly of the cylinder head 46, making it possible to further reduce the size increase in the engine 36.

[0079] The projected portion 66 has the opening portion 78, which represents the downstream end of the exhaust gas passage 80, and the opening portion 78 has its center 79, which is not on a more outer side than the head main body 65 in the left-right direction when viewed from the direction of the cylinder axis A. The arrangement reduces projection of the projected portion 66 outwardly of the cylinder head 46, making it possible to further reduce dimensional increase in the engine 36.

[0080] The outer circumferential surface of the head main body 65 has the recess 68 which recesses inwardly of the head main body 65 as viewed from the direction of cylinder axis A, and the projected portion 66 is formed in the recess 68. Such an arrangement as the above allows mounting of the oxygen concentration sensor 50 to the projected portion 66 closely to the recess 68, making it possible to reduce projection of the projected portion 66 outwardly of the cylinder head 46. Therefore, the cylinder head 46 can be made compactly.

[0081] The recess 68 recesses upwardly and laterally. Also, the recess 68 is formed as a recessed corner portion of the head main body 65. The arrangement makes it possible to form the cylinder head 46 compactly while ensuring a sufficient length for the projected portion 66 which is formed in the recess 68.

[0082] The cover mounting surface 110 and the sensor mounting surface 112 are parallel to each other. The arrangement makes it easy to form the cover mounting surface 110 and the sensor mounting surface 112 by machining.

[0083] The cylinder axis A is slanted in an obliquely forward and upward direction. This makes it possible to reduce downward projection of the engine 36. Therefore, such a configuration can be utilized suitably to a saddle-riding type vehicle which includes a single-cylinder or a V-twin-cylinder engine.

[0084] It should be noted here that although the embodiment described above utilizes a link mechanism 24, the power unit 26 may be mounted directly to the motorcycle frame 12, pivotably in the up-down direction without utilizing the link mechanism 24.

[0085] The transmission member 98 may be provided by a rubber belt for example. In this case, the rotation member 90 will be provided by a pulley.

[0086] Fig. 9 is a drawing when an engine 36a according to another embodiment of the present invention is viewed from front, on a cylinder axis A.

[0087] In the engine 36a, the oxygen concentration sensor 50 is replaced by an oxygen concentration sensor 50a which has an electric wire 124a; the electric wire 124 is replaced by an electric wire 124b; and holding portions 140 are formed in the cylinder head cover 48. Other configurations are the same as the engine 36 in Fig. 4 through Fig. 7, so repetitive description will not be given here.

[0088] The oxygen concentration sensor 50a has a main body portion 118a. An end of the electric wire 124a is connected to an inside of the main body portion 118a, and the electric wire 124a is drawn out of the main body portion 118a. The other end of the electric wire 124a is connected with the engine controller 126 via the electric wire 124b. It should be noted here that the electric wires 124a and 124b have connectors 125a and 125b respectively. Connecting the connectors 125a and 125b with each other establishes connection between the electric wires 124a and 124b.

[0089] The cylinder head cover 48 has its front surface provided with a plurality (four in the present embodiment) of holder portions 140. These holding portions 140 hold the electric wire 124a which is connected with the main body portion 118 of the oxygen concentration sensor 50a. The holding portions 140 may be formed integrally with the cylinder head cover 48 or separately as individual parts. Also, the holding portions 140 may be provided by an adhesive or a sticking tape which presses the electric wire 124a onto the cylinder head cover 48. Further, the holding portions 140

may be provided by generally C-shaped or U-shaped structures through which the electric wire 124a be inserted and thereby held. Also, as indicated by an alternate long and short dash lines in Fig. 9, the holding portions 140 may be formed on the right side surface of the cylinder head cover 48. Further, the holding portions 140 may be formed in whichever of the left side surface, an upper surface and a lower surface of the cylinder head cover 48.

[0090] The holding portions 140 which hold the electric wire 124a along the cylinder head cover 48 as described make it possible to route the electric wire 124a away from the exhaust gas passage 80 that is formed in the cylinder head 46. Therefore, detrimental effect of exhaust gas heat from the exhaust gas passage 80 to the electric wire 124a is now reduced. The arrangement reduces deterioration of the electric wire 124a. Routing the electric wire 124a along the cylinder head cover 48 also provides an advantage of reduced space for the electric wire 124a out of the engine 36a. Also, using the holding portions 140 makes routing of the electric wire 124a easy.

[0091] It should be noted here that the holding portions 140 may be used in the previous embodiment. In this case, the holding portions 140 hold the electric wire 124 which is connected with the oxygen concentration sensor 50.

[0092] Fig. 10 is a partially unillustrated right side view, showing the engine 36 mounted with an air shroud 142.

[0093] As exemplified in Fig. 10, the engine 36 shown in Fig. 4 through Fig. 7 may be provided with the air shroud 142; the air shroud 142 may have its surface formed with holding portions 140; and the electric wire 124 connected with the oxygen concentration sensor 50 may be held by the holding portions 140. Further, the holding portions 140 may be provided in the cylinder head 46.

[0094] Fig. 11 (a) is a drawing of a primary portion and an adjacent region of the cylinder head cover 48 formed with a sensor cover portion 144 as viewed from front on the cylinder axis A. Fig. 11(b) is a perspective view thereof.

[0095] As shown in Fig. 11(a) and Fig. 11(b), the sensor cover portion 144 may be formed integrally with the cylinder head cover 48, at a corner portion of the cylinder head cover 48 near the oxygen concentration sensor 50.

[0096] The sensor cover portion 144 has a cover front-portion 146 which covers a front portion of the main body portion 118 of the oxygen concentration sensor 50; and a cover side-portion 148 which partially covers an outward surface of the main body portion 118. Note, here, that the term "outward" of the main body portion 118 refers to all radial directions which are perpendicular to the center axis B of the oxygen concentration sensor 50 and extending radially outward from the center axis B.

[0097] A motorcycle 10 mounted with an engine 36 which has a cylinder head cover 48 formed with the sensor cover portion 144 can protect the oxygen concentration sensor 50 appropriately, from bouncing stones, etc. from the road surface. The oxygen concentration sensor 50 mounted to the cylinder head 66 overlaps the projected portion 66 as viewed from the direction of the cylinder axis A, and is in proximity to the cylinder head 46. Therefore, the sensor cover portion 144 is not increased in size.

[0098] Fig. 12 (a) is a drawing of a primary portion and an adjacent region of the cylinder head cover 48 formed with a sensor cover portion 144a as viewed from front on the cylinder axis A. Fig. 12(b) is a perspective view thereof.

[0099] As shown in Fig. 12(a) and Fig. 12(b), the sensor cover portion 144a, which is a separate part, may be mounted with fasteners 150 such as bolts, to a corner portion of the cylinder head cover 48 near the oxygen concentration sensor 50. The sensor cover portion 144a has a cover front-portion 146a which covers a front portion of the main body portion 118 of the oxygen concentration sensor 50; and a cover side-portion 148a which partially covers an outward surface of the main body portion 118.

[0100] Again, in this case, the arrangement provides the same advantages as offered by the case where the engine 36 has the cylinder head cover 48 formed with the sensor cover portion 144.

[0101] It should be noted here that the fasteners 150 are not limited to bolts, but may be whatever fastening members which are capable of providing appropriate fastening. The cylinder head cover 48 may be provided with a rotation stopper (not illustrated), formed as a projection for example, in order to prevent rotation of the sensor cover portion 144a which is mounted to the cylinder head cover 48.

[0102] In cases where the oxygen concentration sensor is provided by the oxygen concentration sensor 50a in Fig. 9, the sensor covers 144, 144a may be formed in the cylinder head cover 48.

[0103] Also, the sensor cover portions 144, 144a may only have the cover-front portions 146, 146a respectively, for covering at least a front portion of the main body portion 118 of the oxygen concentration sensor 50.

[0104] Fig. 13 is a drawing, with a partial section, of an engine 36b according to still another embodiment of the present invention.

[0105] Referring to Fig. 13, the engine 36b includes a cylinder head 46a, where a cover mounting surface 110 for mounting the cylinder head cover 48 and a sensor mounting surface 112a for mounting the oxygen concentration sensor 50 are in the same plane. Specifically, the cover mounting surface 110 and the sensor mounting surface 112a are flush with each other. Other configurations are the same as the engine 36 in Fig. 7, so repetitive description will not be given here.

[0106] In this case, the arrangement allows simultaneous machining of the cover mounting surface 110 and the sensor mounting surface 112a, making it even easier to obtain the cylinder head 46a.

[0107] Fig. 14 is a drawing when an engine 36c according to still another embodiment of the present invention is viewed from front, on a cylinder axis A.

[0108] In the engine 36c shown in Fig. 14, the cylinder head 46 which has the projected portion 66 is replaced by a cylinder head 46b which has a projected portion 66a.

[0109] When the engine 36c is viewed from front on the cylinder axis A, the projected portion 66a projects downward from the cylinder head 46b, and the downstream end of the exhaust gas passage 80a represented by an opening portion 78a is oriented in an obliquely leftward and downward direction. Also, the cylinder head 46b is formed with an exhaust gas passage 80a, which extends downward from a combustion chamber 90 and an exhaust gas port 82. Other configurations are the same as the engine 36 in Fig. 4, so repetitive description will not be given here.

[0110] The engine 36c provides the same advantages as the engine 36.

[0111] Fig. 15 is a drawing of a primary portion, showing an oxygen concentration sensor 50 mounted on a projected portion 66 at a slant. Fig. 16 is a drawing of a section taken in lines III-III in Fig. 15.

[0112] As shown in Fig. 15 and Fig. 16, the oxygen concentration sensor 50 may be slanted so that its center axis B is skewed with respect to the cylinder axis A. For a comparative purpose, alternate long and two short dashes lines show the oxygen concentration sensor 50 which is disposed so that its center axis B is parallel to the cylinder axis A.

[0113] The angle of the center axis B with respect to the cylinder axis A is discretionary as long as the main body portion 118 and the detection portion 120 of the oxygen concentration sensor 50 overlap the projected portion 66 of the cylinder head 46 when viewed from the direction of the cylinder axis A. In other words, with reference to Fig. 16, the oxygen concentration sensor 50 may be slanted to the cylinder axis A, within a range that the main body portion 118 and the detection portion 120 will not be out of a range defined by a line C and a line D. The line C makes contact with an end of the projected portion 66, and is parallel to the cylinder axis A whereas the line D makes contact with the other end of the projected portion 66, and is parallel to cylinder axis A.

[0114] It should be noted here that the requirement is only that the main body portion 118 be located between the line C and the line D when viewed from the direction of the cylinder axis A. The electric wire 124 (124a) connected with the main body portion 118 need not be between the line C and the line D.

[0115] Fig. 17 (a) is a drawing when a V-twin-cylinder engine 36d according to still another embodiment of the present invention is viewed from a side. Fig. 17 (b) is a drawing when the engine 36d is viewed from above.

[0116] In the engine 36d, each of the two cylinder heads 46 is provided with the oxygen concentration sensor 50. The oxygen concentration sensor 50 may be mounted to only one of the cylinder heads 46 in the two cylinders, to control the engine 36d.

[0117] As described, the present invention is applicable not only to single-cylinder engines but also to V-twin-cylinder engines in which a plurality of cylinders do not line up in the left-right direction.

[0118] Fig. 18 is a left side view of a motorcycle 10a according to another embodiment of the present invention.

[0119] The motorcycle 10a is a so-called underbone type motorcycle in which an engine 36e is disposed below a motorcycle frame 152.

[0120] Referring to Fig. 18, the motorcycle 10a includes a motorcycle frame 152. The motorcycle frame 152 includes a head pipe 154, a main frame 156 and a seat frame 158. The head pipe 154 is at a front end portion of the motorcycle frame 152, at a lateral center thereof. The main frame 156 extends from the head pipe 154 in an obliquely rearward and downward direction in a lateral center plane. The seat frame 158 extends from the main frame 156 in an obliquely rearward and upward direction.

[0121] The head pipe 154 supports a front fork 160 steerably in the left-right direction, and the front fork 160 rotatably supports a front wheel 162 at its lower end portion. The front fork 160 has its upper end portion provided with a steering handlebar 164.

[0122] The engine 36e is an air-cooled, single-cylinder engine, supported by the main frame 156 from above, with its crankshaft 166 oriented in the lateral direction of the motorcycle. The engine 36e is fixed to the motorcycle frame 152 and does not pivot thereto. The engine 36e has a rear end portion, which supports a rear arm 168 pivotably in an up-down direction, and the rear arm 168 has a rear end portion, which supports a rear wheel 170. A seat 172 is provided above the seat frame 158. The motorcycle frame 152 and the engine 36e have their left and right sides covered by a body cover 174.

[0123] The engine 36e includes a crank case 176 which incorporates a crankshaft 166 and a transmission (not illustrated); a cylinder body 44; a cylinder head 46 and a cylinder head cover 48. The cylinder body 44, the cylinder head 46 and the cylinder head cover 48 are identical with those included in the engine 36.

[0124] The crankcase 176, the cylinder body 44, the cylinder head 46 and the cylinder head cover 48 are on a cylinder axis A of the engine 36e, in this order from rear to front, in the fore-aft direction of the motorcycle. The crankcase 176, the cylinder body 44, the cylinder head 46 and the cylinder head cover 48 are connected with their adjacent members. The cylinder axis A is slanted in an obliquely forward and upward direction with respect to the fore-aft direction of the motorcycle. In this embodiment, the axis A is slanted slightly. In the motorcycle 10a, the rear wheel 170 is driven by a chain.

[0125] The cylinder head 46 has an upper surface connected with an air intake apparatus 178, which communicates with an air intake passage 74. Also, like the engine 36 in Fig. 4, the cylinder head 46 has a projected portion 66 connected with an exhaust apparatus 56, which communicates with an exhaust gas passage 80.

[0126] The motorcycle 10a which includes the engine 36e also provides the same advantages as provided by the motorcycle 10.

[0127] It should be noted here that an engine such as the engines 36a through 36d; a cylinder head cover provided with a sensor cover as shown in Fig. 11 and Fig. 12; and an oxygen concentration sensor slanted with respect to the cylinder axis A as shown in Fig. 15 and Fig. 16 may also be applied to the motorcycle 10a.

[0128] In the embodiments described above, there is no specific limitation to the angle made by the cylinder axis A and the motorcycle's fore-aft direction. The angle may be a zero degree. Specifically, the cylinder axis A may be identical with the fore-aft direction of the motorcycle. The present invention is also applicable to an engine whose cylinder axis A is in the vertical or substantially vertical direction. Also, the engine according to the present invention may be of a liquid-cooled type.

[0129] The oxygen concentration sensor 50 may be mounted to the projected portion 66 so that the main body portion 118 is located at a more rearward position than the detection portion 120. In this case, a front portion and a rear portion of the main body portion 118 are covered by the cylinder head 46 and the crankcase 42 respectively. A motorcycle mounted with an engine which has the oxygen concentration sensor 50 can protect the oxygen concentration sensor 50 appropriately, from bouncing stones, etc. from the road surface. The main body portion 118 included in the oxygen concentration sensor 50 may have a generally consistent diameter. The diameter of the detection portion 120 may be different depending on its axial positions. This also applies to the oxygen concentration sensor 50a.

[0130] The oxygen concentration sensor employed in the present invention may be whichever of heaterless type and heater-equipped type. Even if the oxygen concentration sensor is provided by a heater-equipped type, power consumption by the oxygen concentration sensor can be reduced.

[0131] The recess formed along the oxygen concentration sensor in the outer circumferential surface of the cylinder head is not limited to be of a curved shape. For example, the recess may have a V shape formed by cutting the corner portion of the outer circumferential surface of the cylinder head in the cylinder axis direction.

[0132] The position of the exhaust gas passage formed in the cylinder head may be determined appropriately according to design requirement for the saddle-riding type vehicle to which the engine is mounted.

[0133] The projected portion preferably projects at least in a downward direction, from the head main body. For example, when viewed from the direction of the cylinder axis, the projected portion may project from the head main body in whichever of an obliquely rightward and downward direction; a downward direction; and an obliquely leftward and downward direction.

[0134] In the embodiments described above, description was made for cases where engines according to the present invention are applied to a scooter-type motorcycle shown in Fig. 1, and to an underbone-type (a horizontal-cylinder type) motorcycle shown in Fig. 18. However, the present invention is not limited to these. The engine according to the present invention is also applicable to motorcycles of other types, such as motorcycle type in which the engine is not the horizontal-cylinder type. Also, the engine according to the present invention is applicable to any other saddle-riding type vehicles including snowmobiles, all-terrain vehicles, etc.

[0135] Application of the engine according to the present invention to a saddle-riding type vehicle makes it possible to reduce size increase of the engine and to reduce size increase of the saddle-riding type vehicle even if the oxygen concentration sensor is provided at a position where the exhaust gas has a high temperature in the cylinder head.

[0136] The present invention being thus far described in terms of preferred embodiments, it is obvious that these may be varied in many ways within the scope and the spirit of the present invention. The scope of the present invention is only limited by the accompanied claims.

[LEGEND]

[0137]

10, 10a	Motorcycles
36, 36a, 36b, 36c, 36d, 36e	Engines
40	Crankshaft
42	Crankcase
44	cylinder body
46, 46a, 46b	Cylinder heads

	48	Cylinder head cover
	50, 50a	Oxygen concentration sensors
5	65	Head main body
	66, 66a	Projected portions
	68	Recess
10	70	Combustion recess
	72, 78, 78a	Opening portions
15	79	Center of opening portion
	80, 80a	Exhaust gas passages
	110	Cover mounting surface
20	112, 112a	Sensor mounting surfaces
	118, 118a	Main body portions
25	120	Detection portion
	124, 124a, 124b	Electric wires
	140	Holding portion
30	144, 144a	Sensor cover portions
	A	Cylinder axis
35	B	Center axis

Claims

- 40 **1.** A single-cylinder or V-twin-cylinder engine, comprising:
- a cylinder head including a head main body and a projected portion projecting outwardly from the head main body;
a combustion recess formed in the head main body;
an exhaust gas passage from the combustion recess through the projected portion for discharging exhaust gas
45 from the combustion recess; and
an oxygen concentration sensor including a main body portion and a detection portion provided in the main
body portion, for detecting an oxygen concentration in the exhaust gas;
wherein the oxygen concentration sensor is mounted to the projected portion, with the main body portion and
the detection portion overlapping the projected portion as viewed from a direction of the cylinder axis, at least
50 part of the detection portion being located within the exhaust gas passage.
- 2.** The engine according to Claim 1, wherein the oxygen concentration sensor as mounted to the projected portion has
the main body portion located at a more forward position than the detection portion.
- 55 **3.** The engine according to Claim 1, wherein the oxygen concentration sensor as mounted to the projected portion has
a center axis parallel to the cylinder axis.
- 4.** The engine according to Claim 1, wherein the projected portion projects from the head main body at least in a

downward direction.

5. The engine according to Claim 4, wherein the projected portion projects from the head main body in an obliquely downward direction when viewed from the direction of the cylinder axis.
6. The engine according to Claim 5, wherein the oxygen concentration sensor does not project beyond the head main body in a left-right direction when viewed from the direction of the cylinder axis.
7. The engine according to Claim 1, wherein the projected portion has an opening portion as a downstream end of the exhaust gas passage, and a center of the opening portion is not on a more outer side than the head main body in a left-right direction when viewed from the direction of the cylinder axis.
8. The engine according to Claim 1, wherein the head main body has an outer circumferential surface with a recess recessing inwardly of the head main body as viewed from the direction of the cylinder axis, the projected portion being formed in the recess.
9. The engine according to Claim 8, wherein the recess recesses upwardly.
10. The engine according to Claim 8, wherein the recess recesses sideways.
11. The engine according to Claim 8, wherein the recess is formed as a recessed corner portion of the head main body.
12. The engine according to Claim 1, further comprising a cylinder head cover provided ahead of the cylinder head; and a sensor cover portion provided in the cylinder head cover for covering at least a front portion of the main body portion.
13. The engine according to Claim 1, further comprising a cylinder head cover provided ahead of the cylinder head, the cylinder head having a cover mounting surface for mounting the cylinder head cover, the projected portion having a sensor mounting surface for mounting the oxygen concentration sensor, the cover mounting surface and the sensor mounting surface being parallel to each other.
14. The engine according to Claim 1, further comprising a cylinder head cover provided ahead of the cylinder head, the cylinder head having a cover mounting surface for mounting the cylinder head cover, the projected portion having a sensor mounting surface for mounting the oxygen concentration sensor, the cover mounting surface and the sensor mounting surface being in a same plane.
15. The engine according to Claim 1, further comprising a cylinder head cover provided ahead of the cylinder head; and an electric wire connected with the main body portion and routed along the cylinder head cover.
16. The engine according to Claim 15, further comprising a holding portion provided in the cylinder head cover for holding the electric wire.
17. A saddle-riding type vehicle comprising the engine according to one of Claims 1 through 16.
18. The saddle-riding type vehicle according to Claim 17, wherein the cylinder axis is slanted in an obliquely forward and upward direction.

FIG. 1

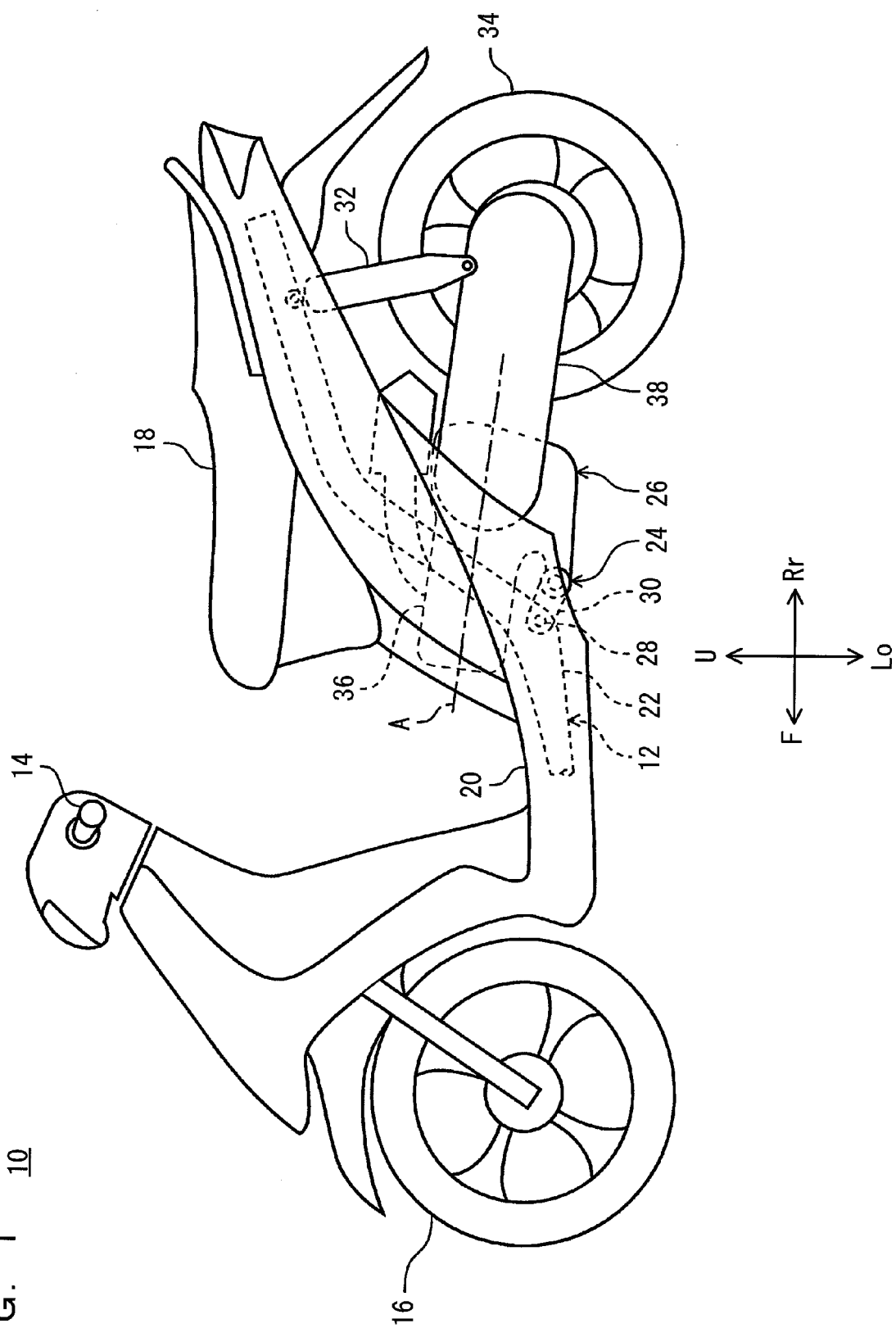


FIG. 2

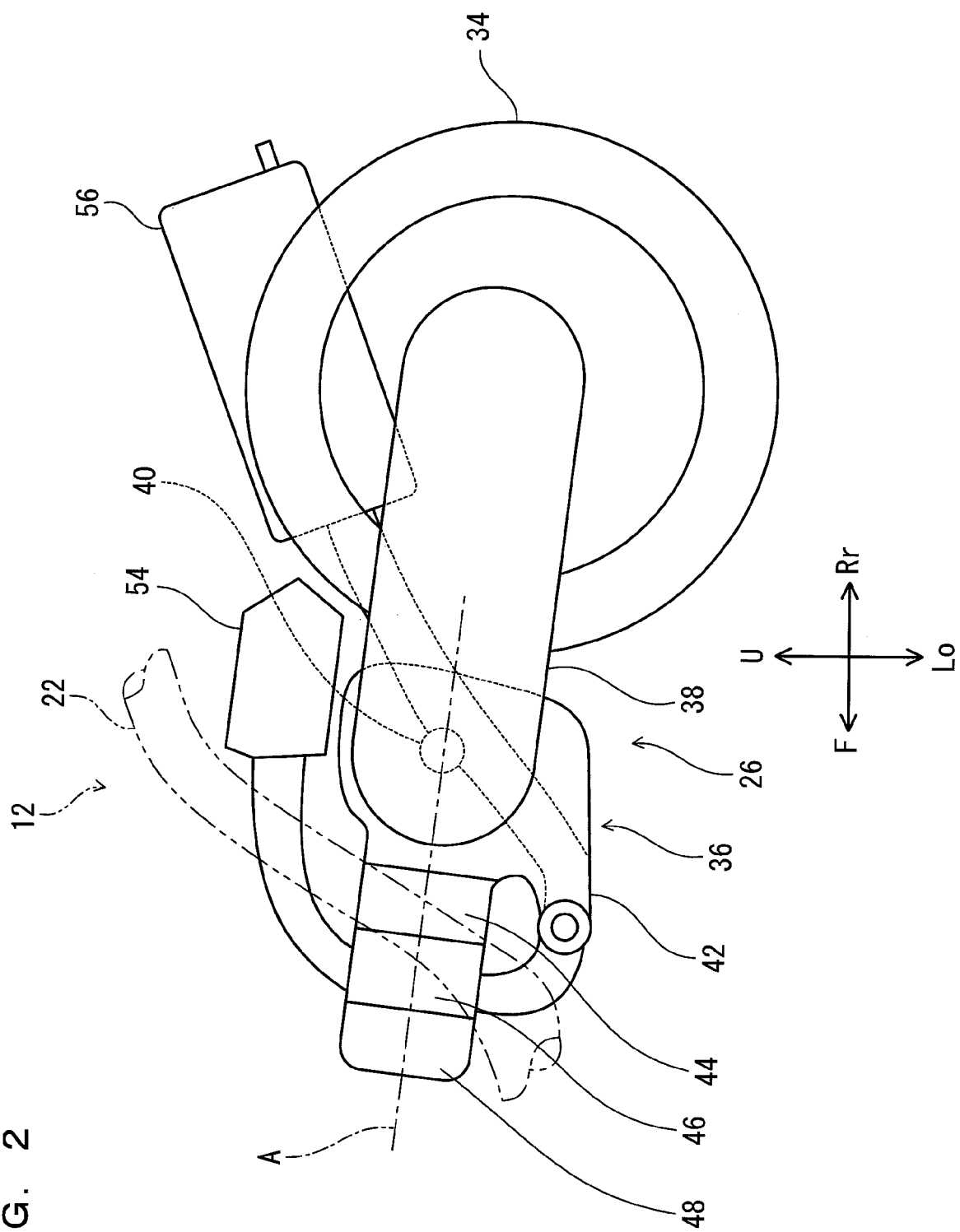


FIG. 3

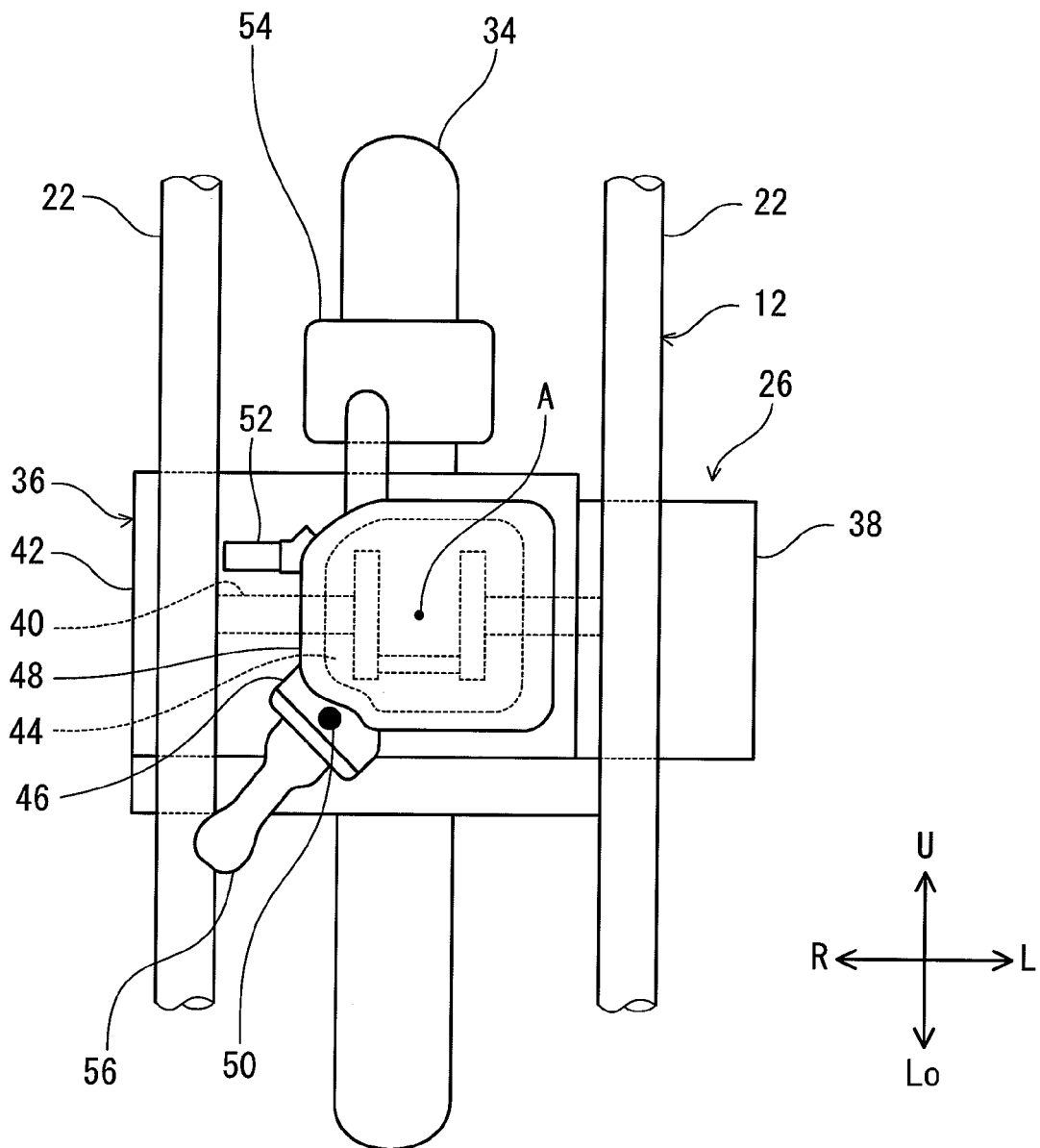


FIG. 4

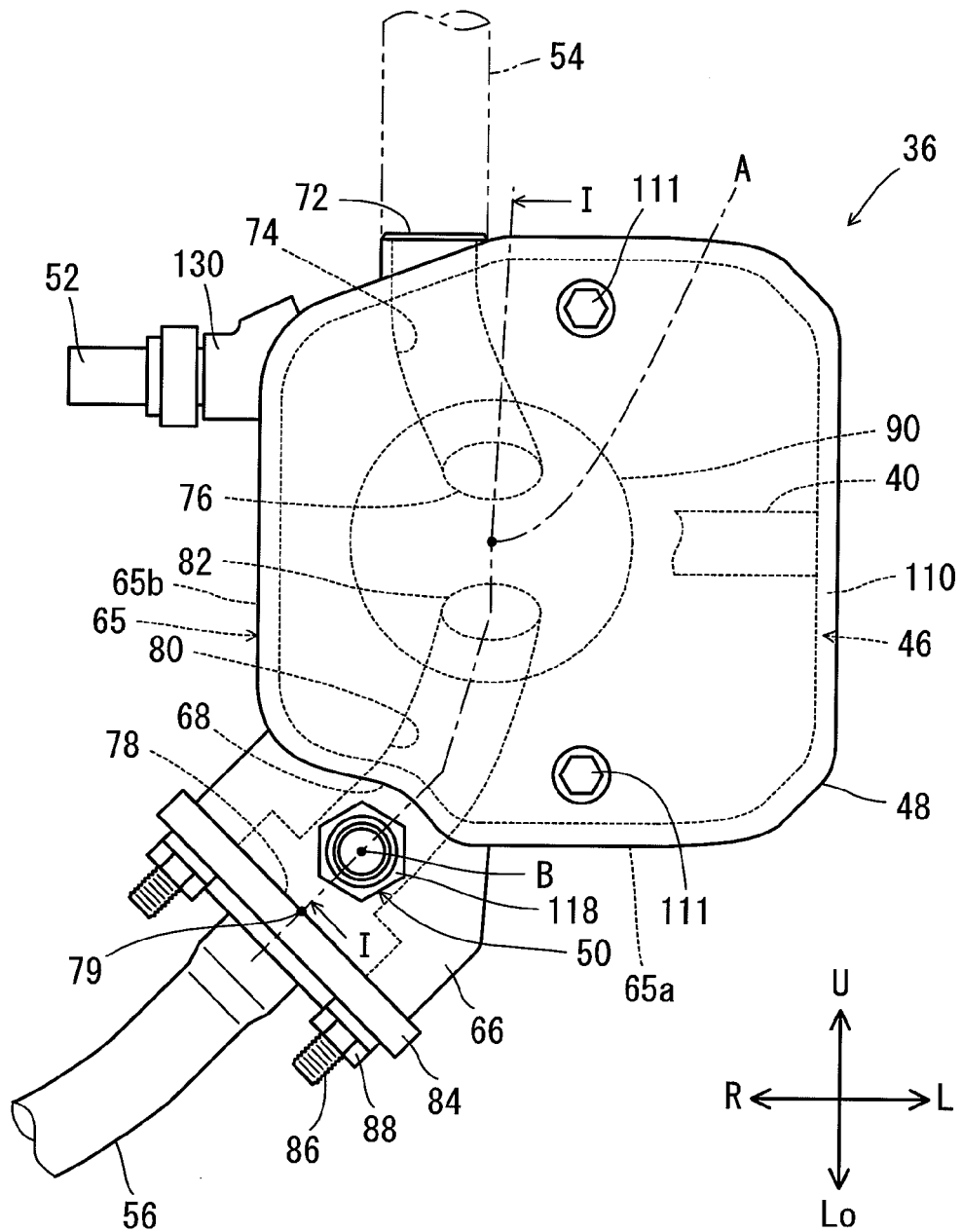


FIG. 5

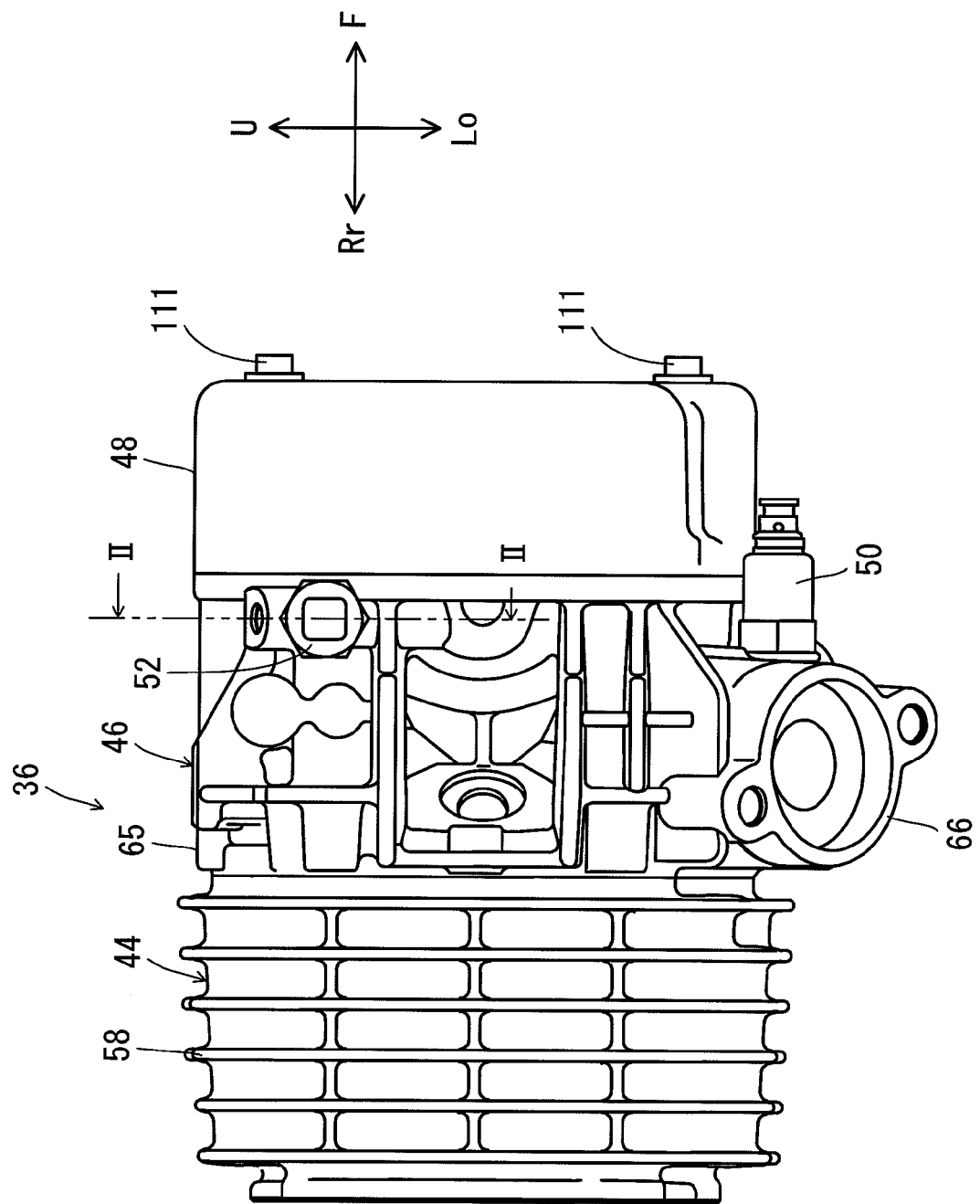


FIG. 6

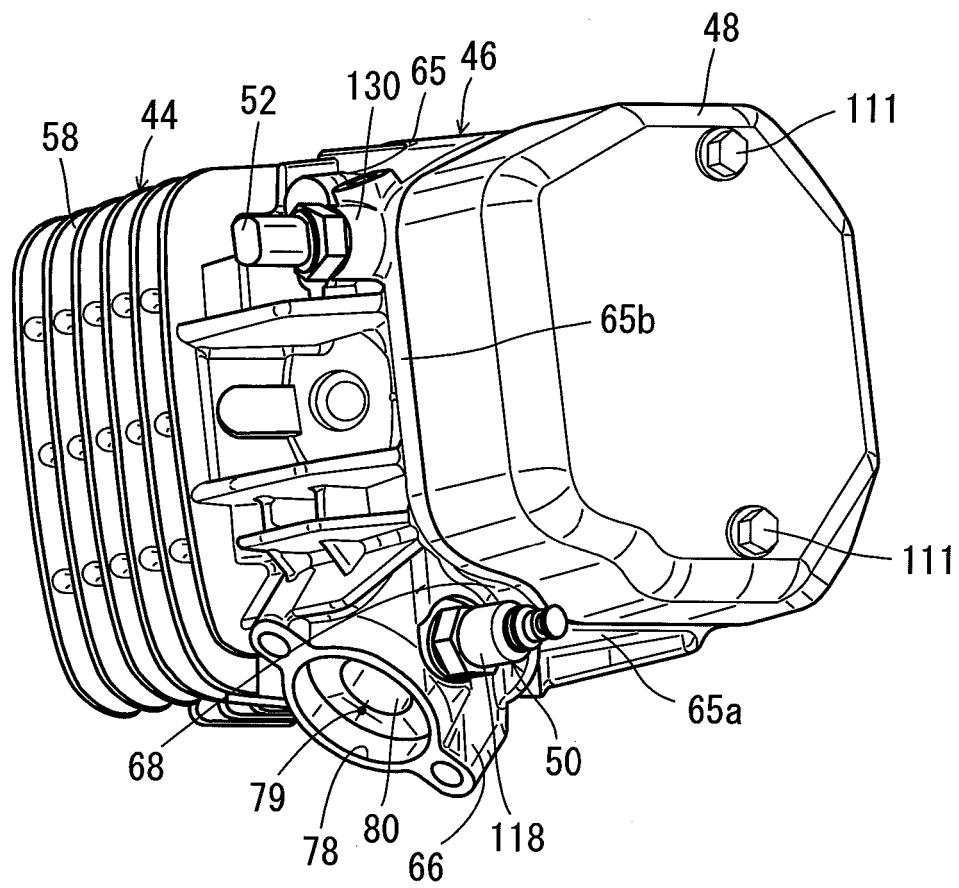


FIG. 7

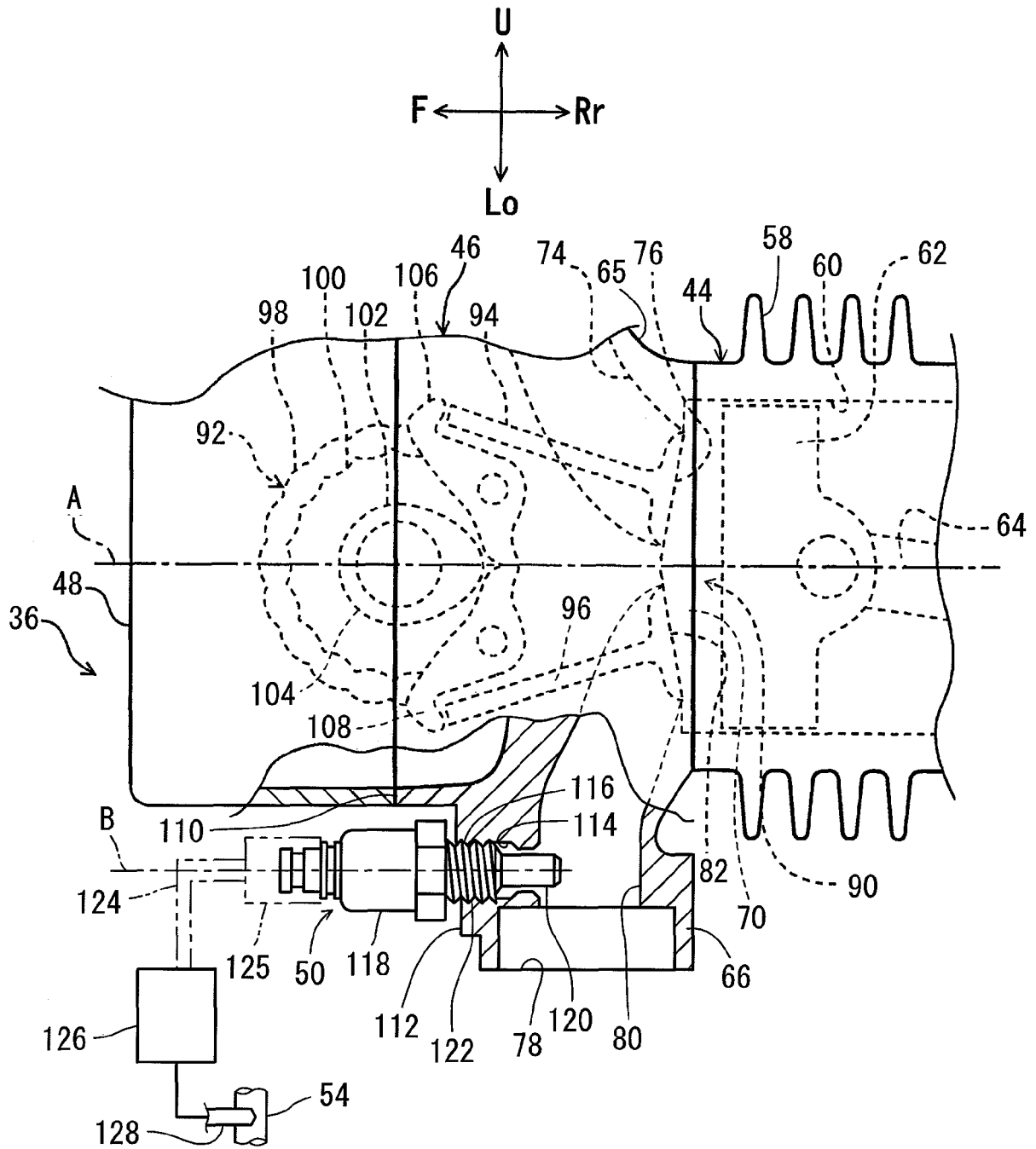


FIG. 8

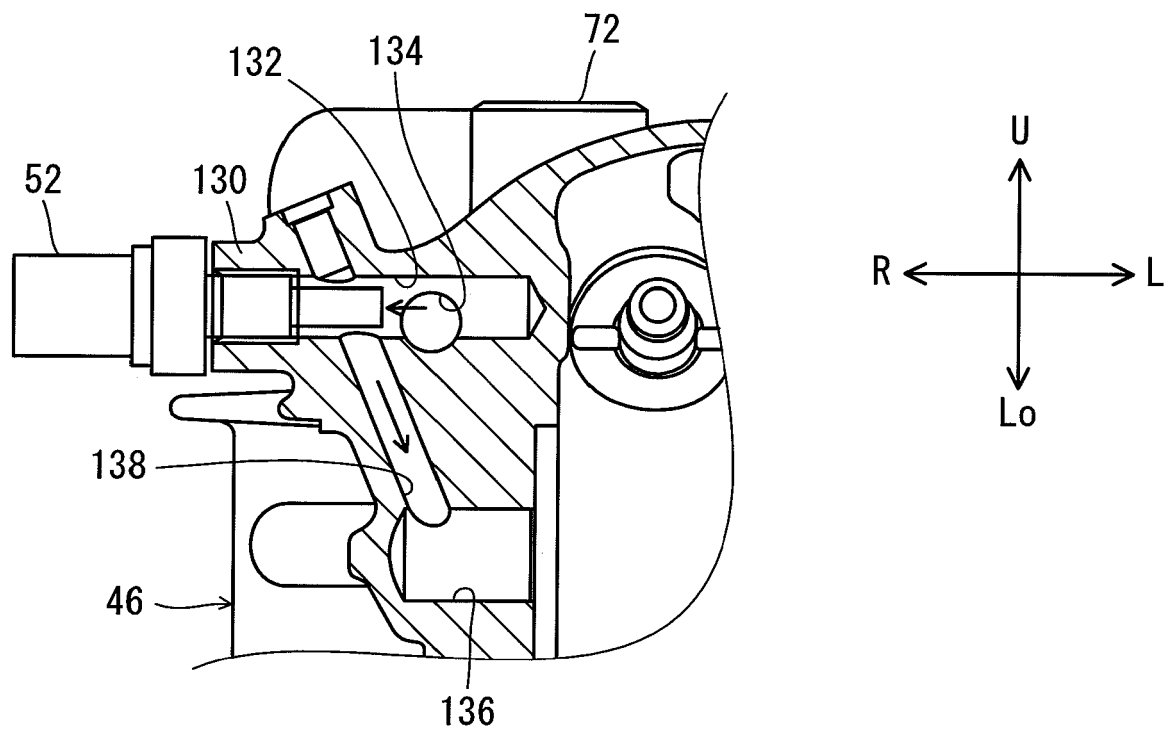


FIG. 9

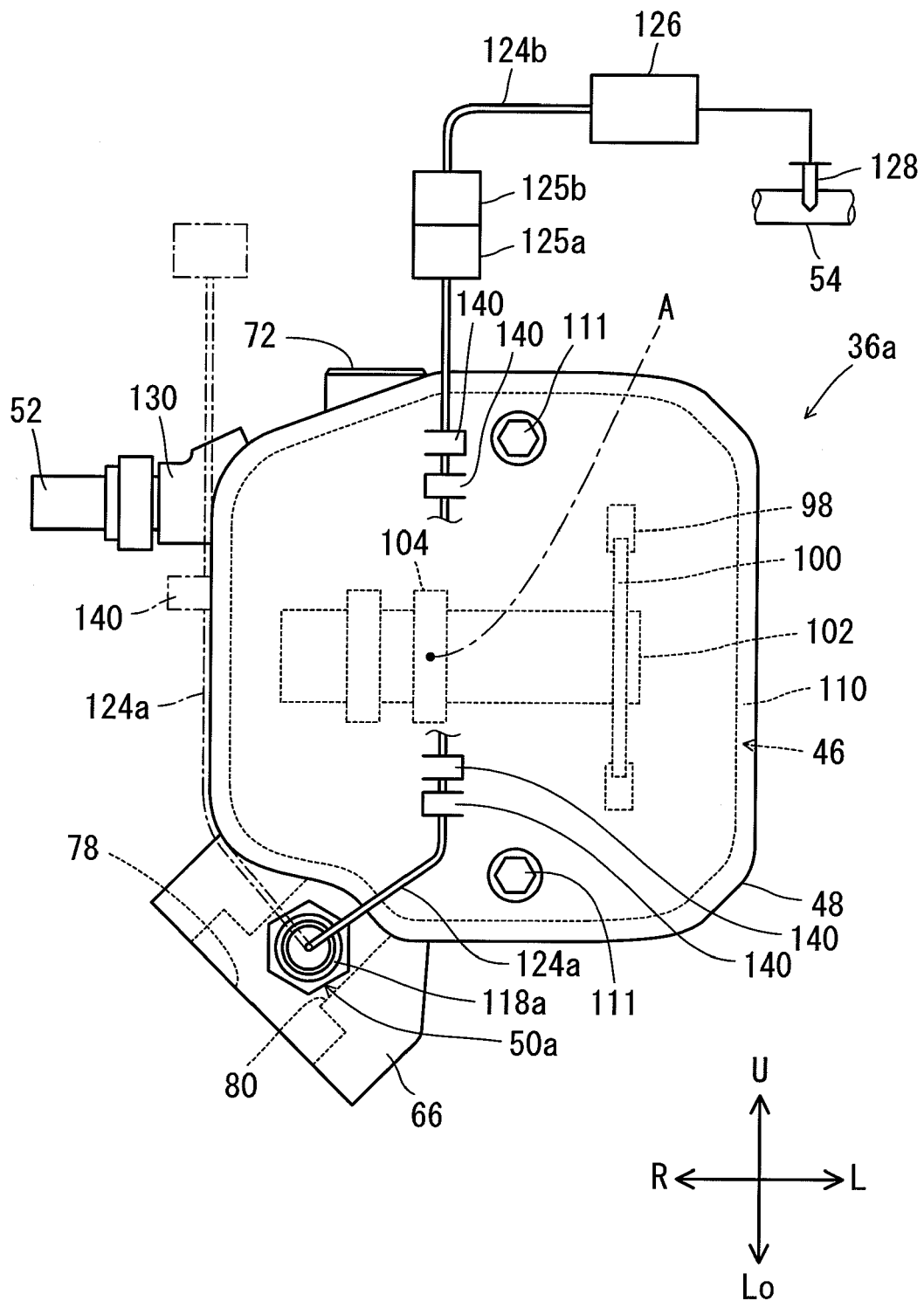


FIG. 10

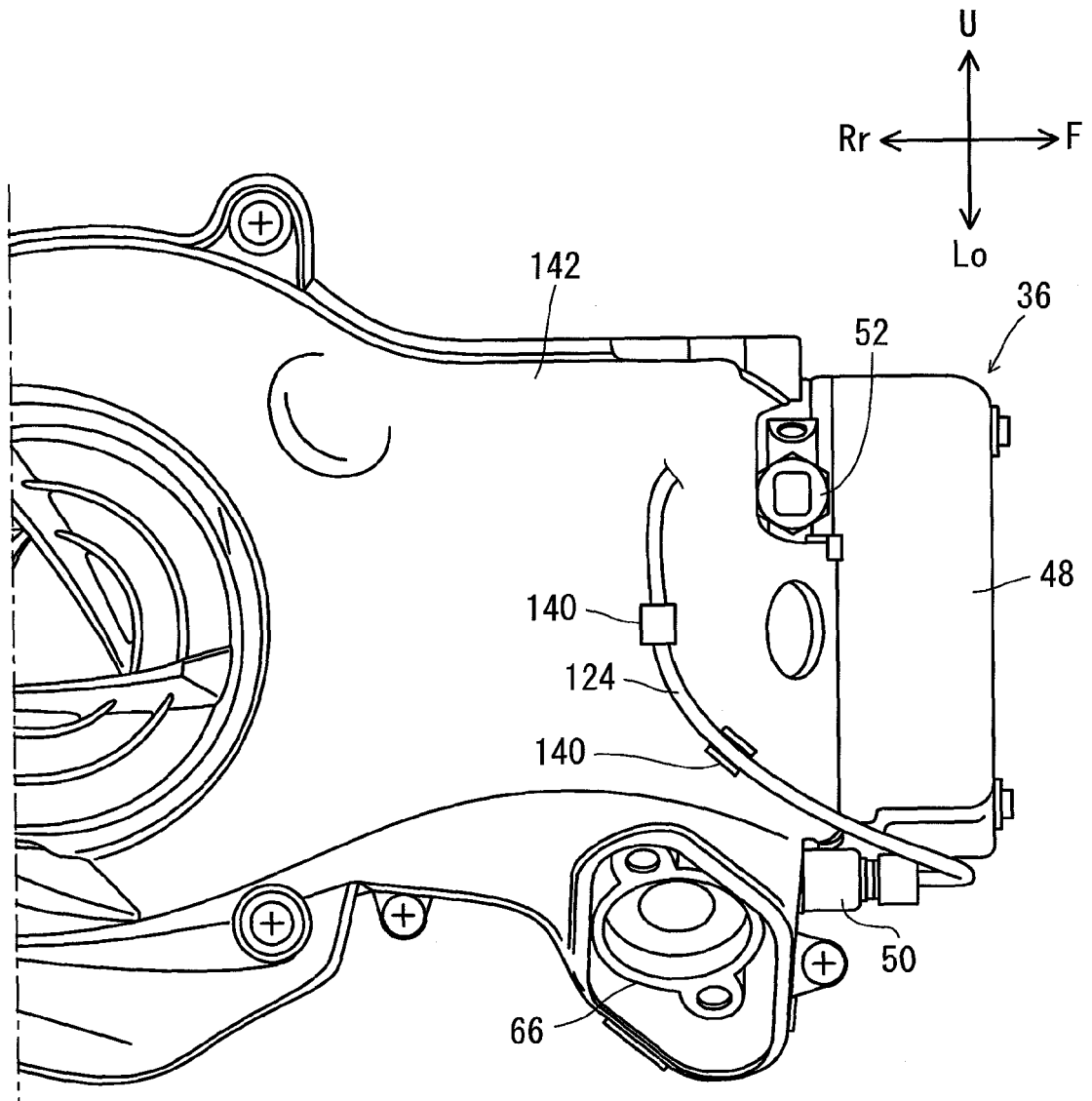
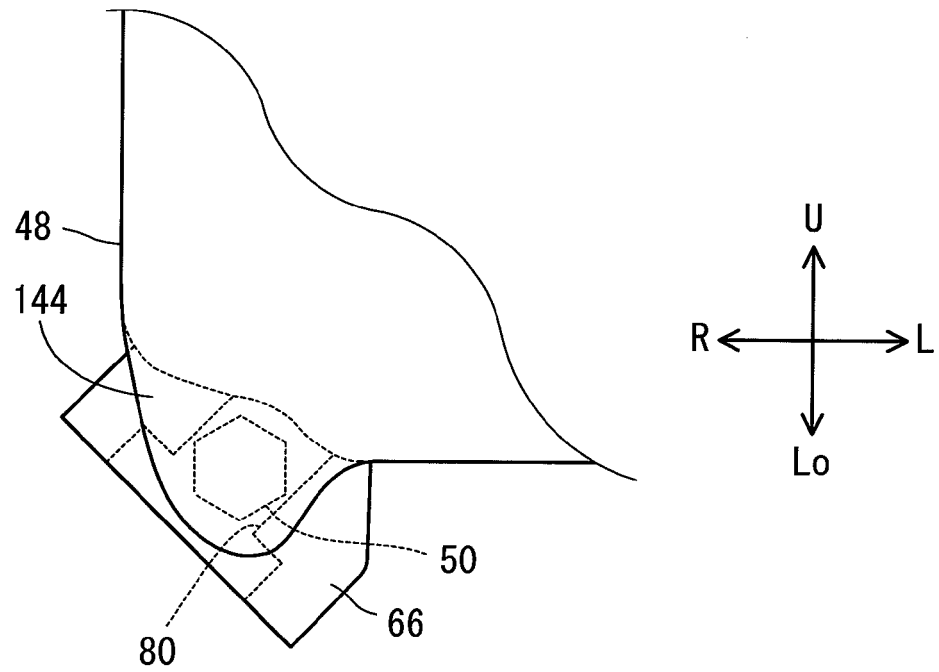


FIG. 11

(a)



(b)

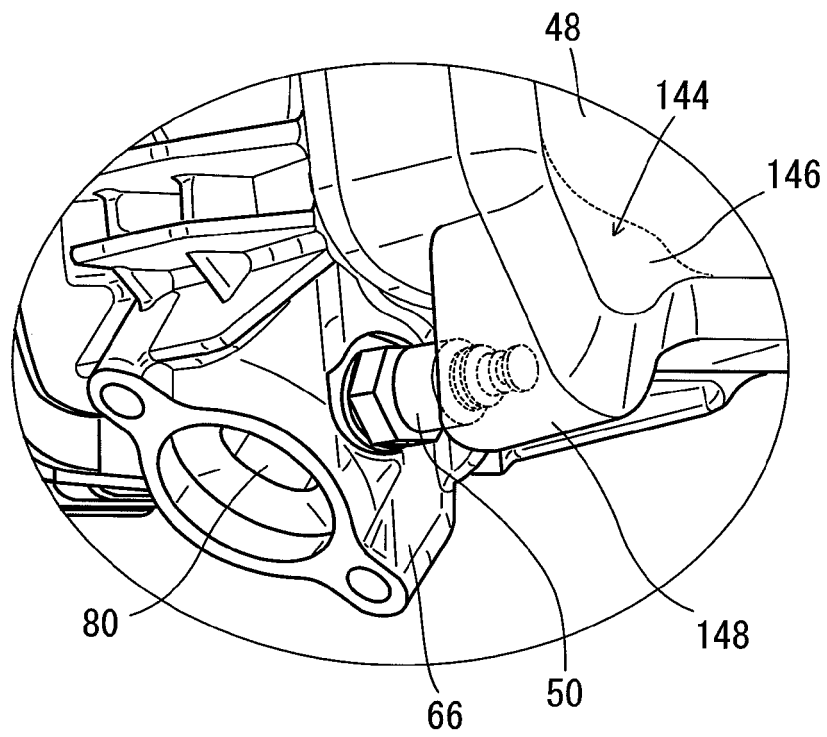
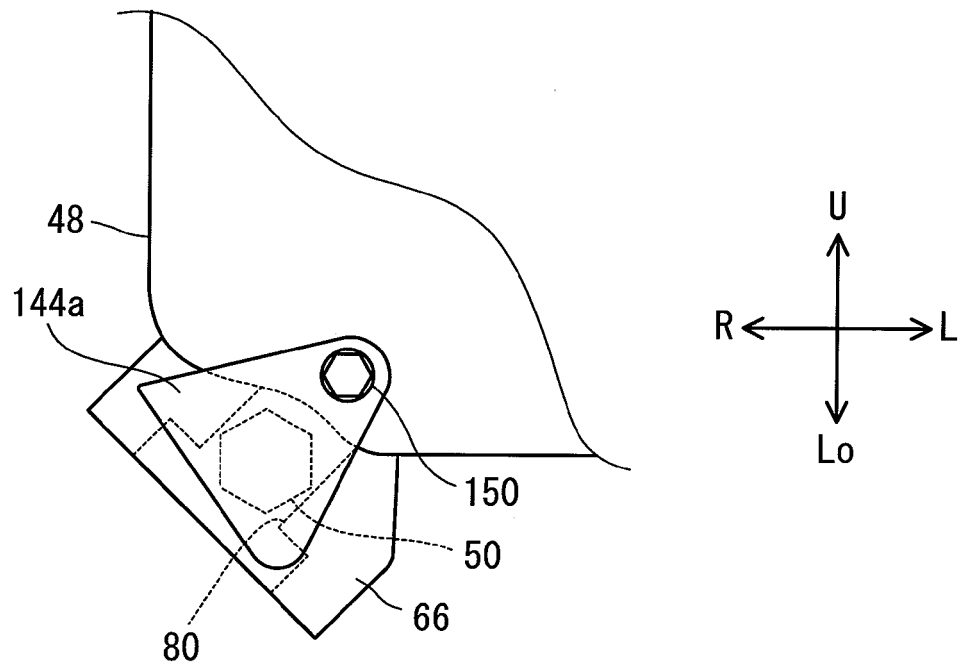


FIG. 12

(a)



(b)

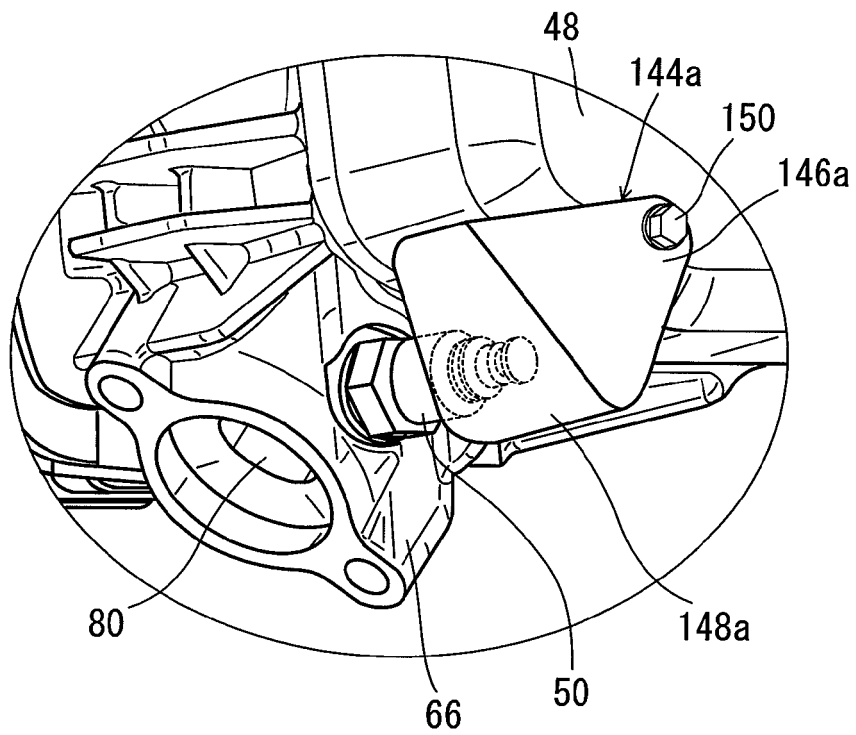


FIG. 13

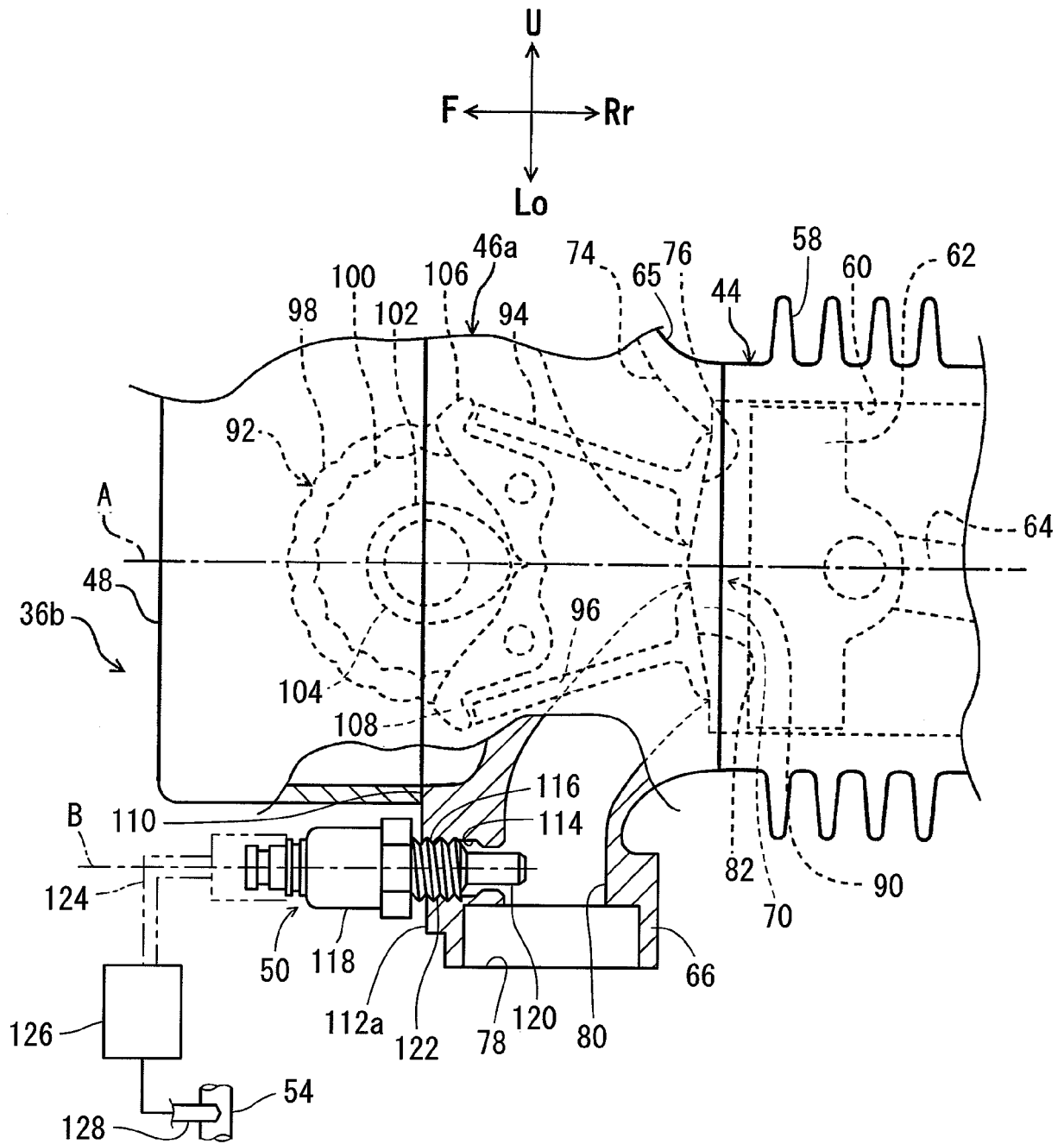


FIG. 14

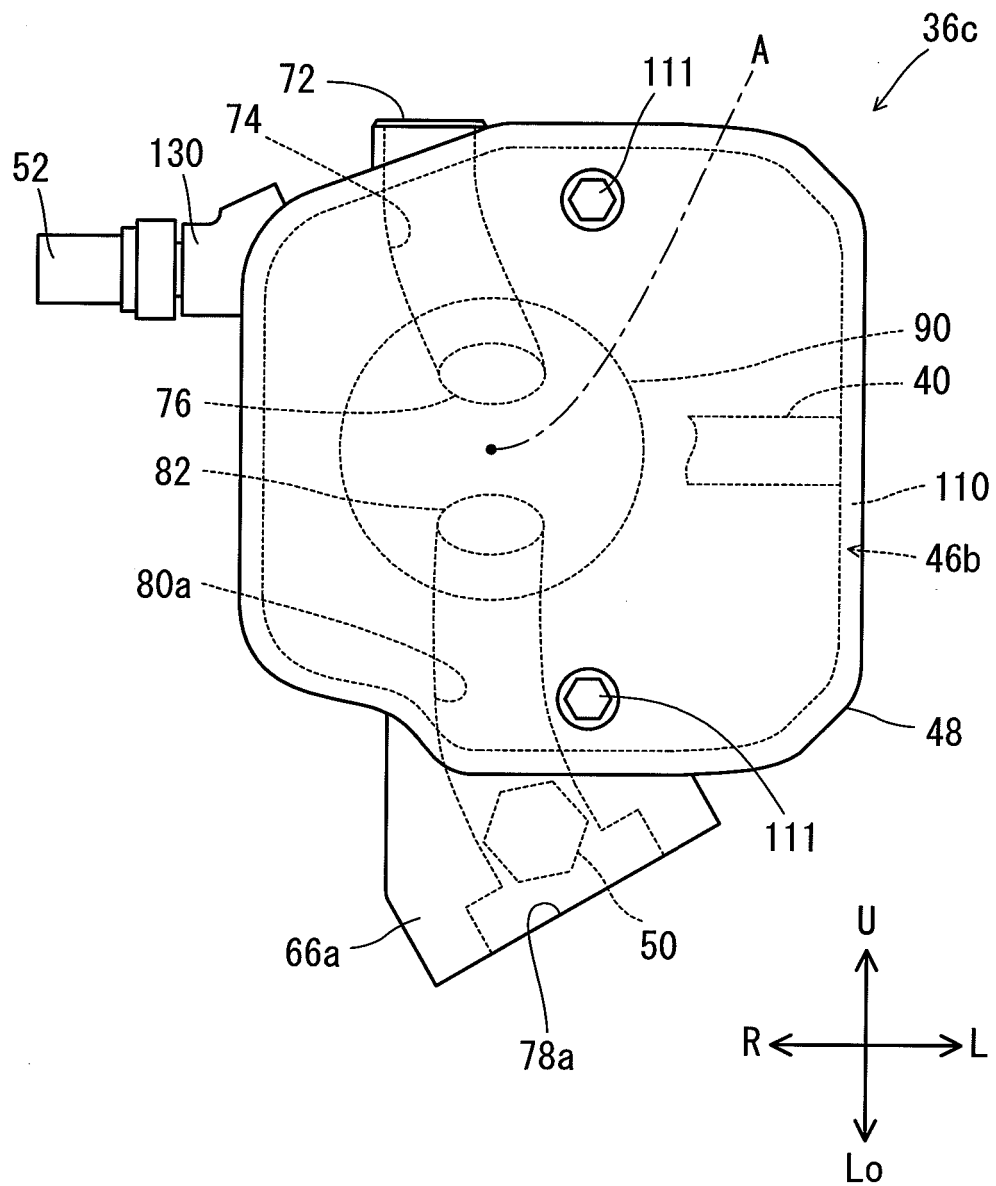


FIG. 15

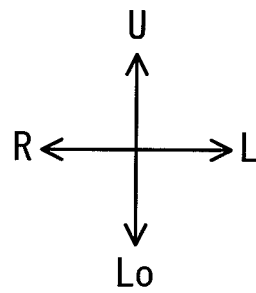
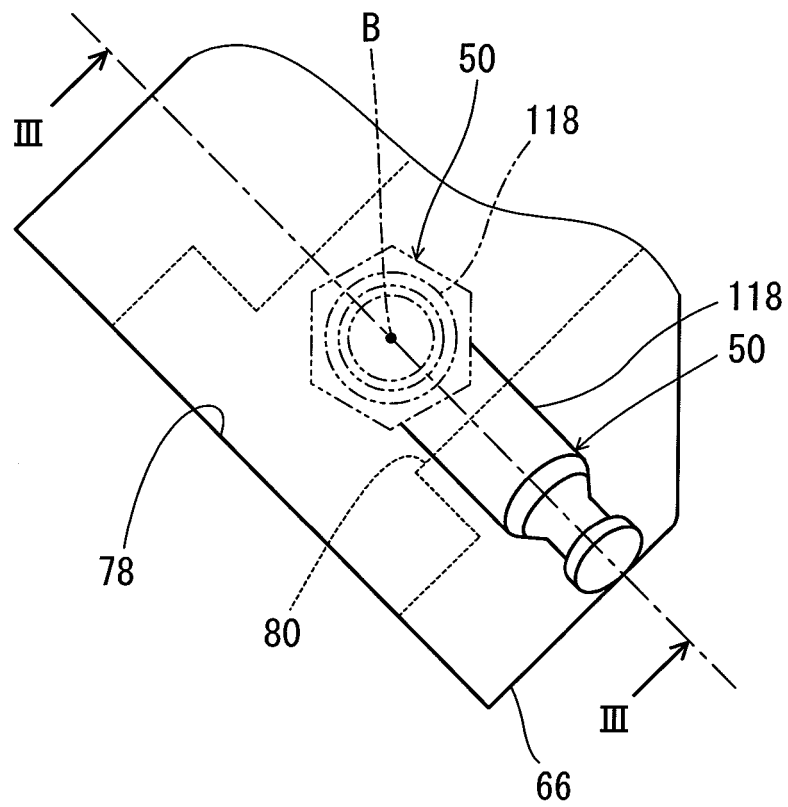


FIG. 16

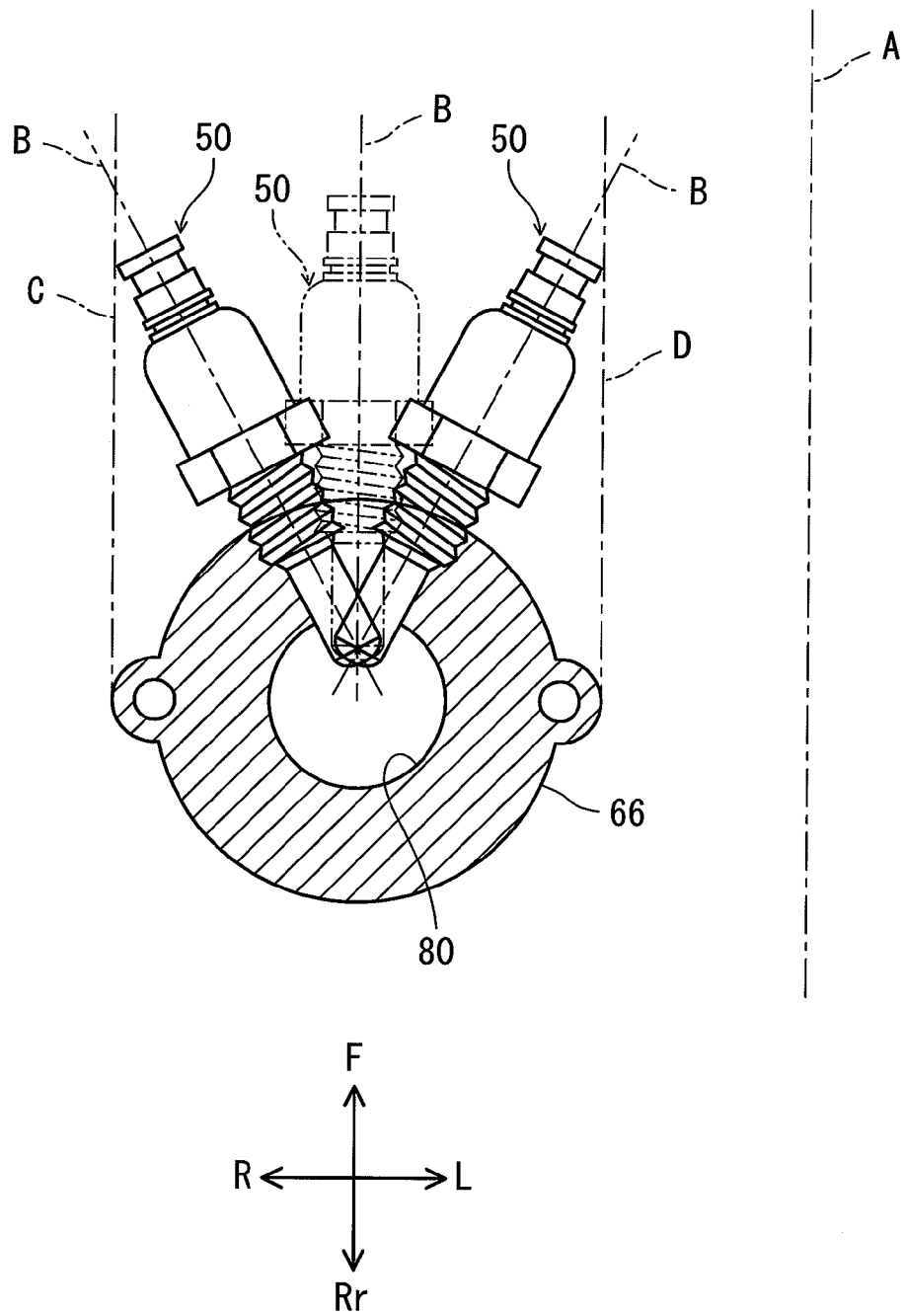
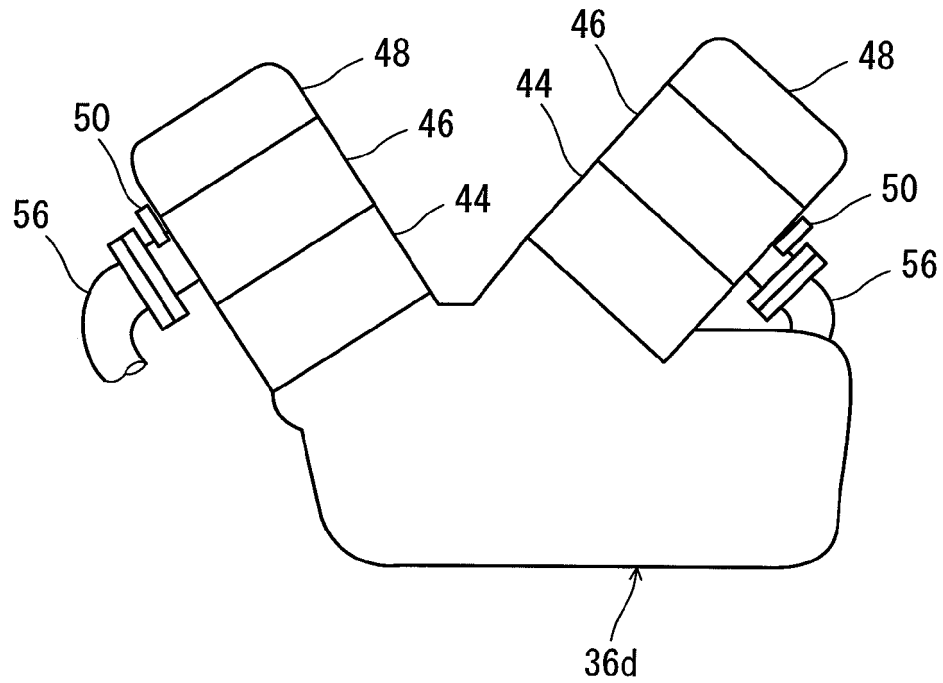


FIG. 17

(a)



(b)

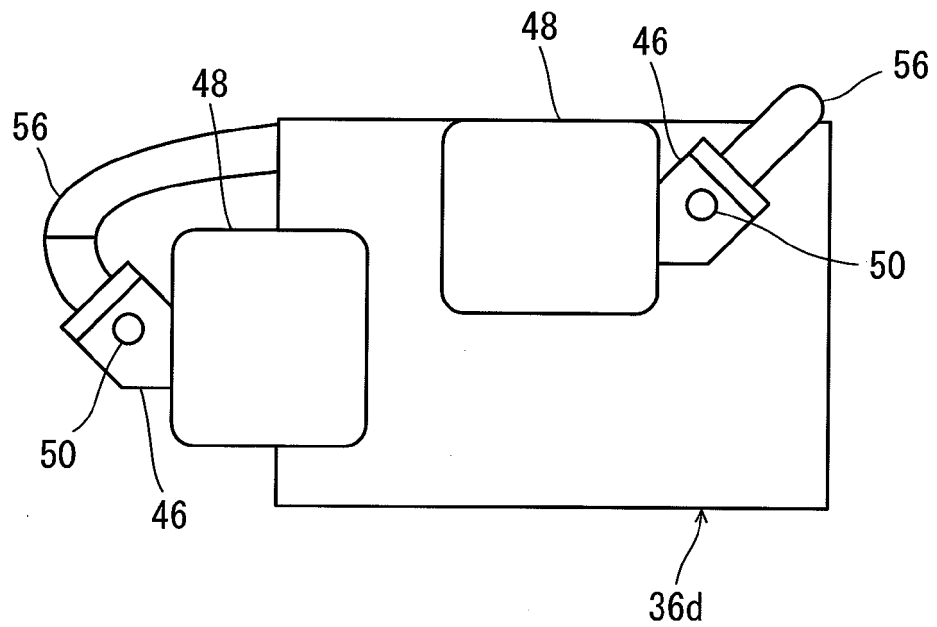


FIG. 18

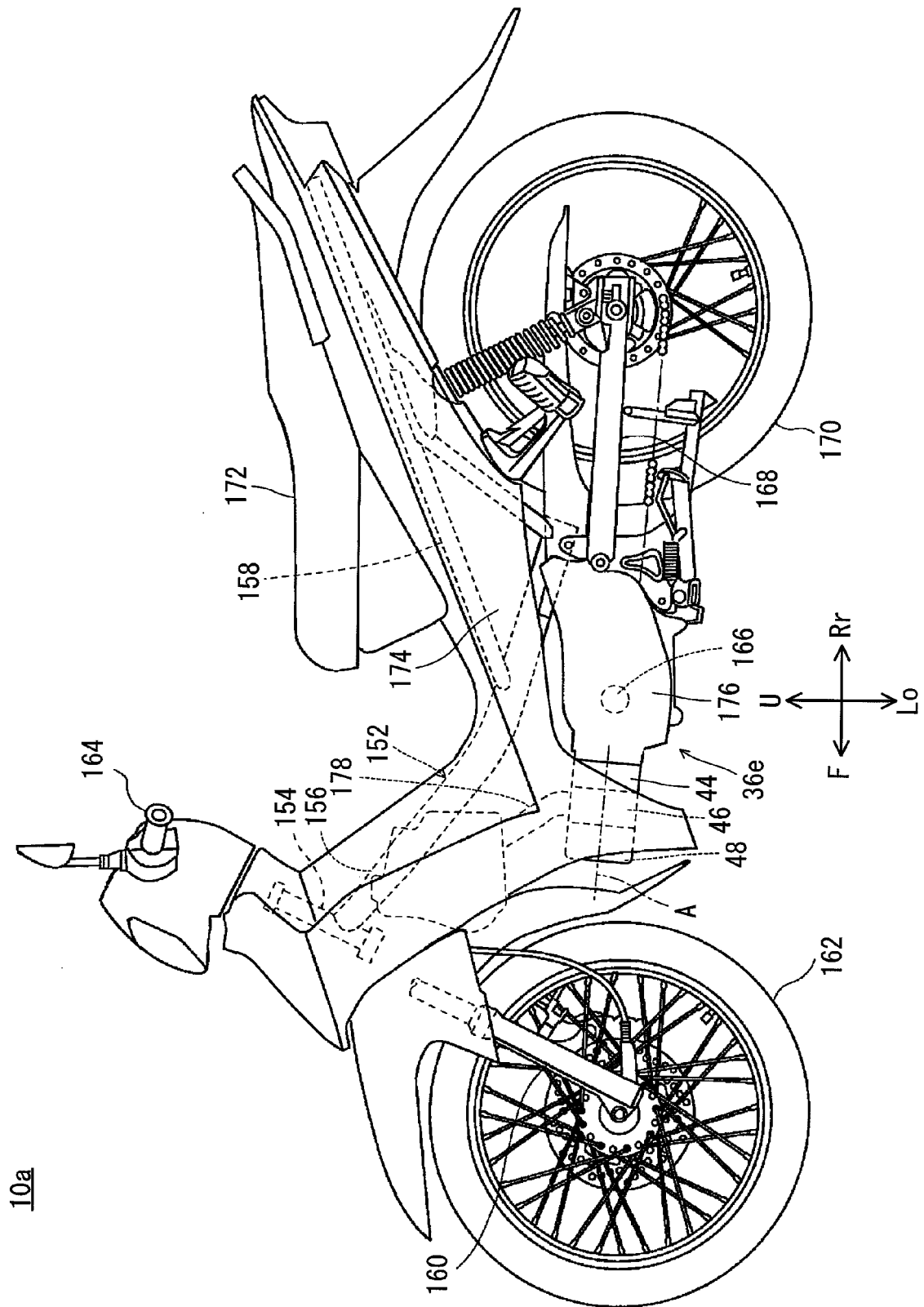
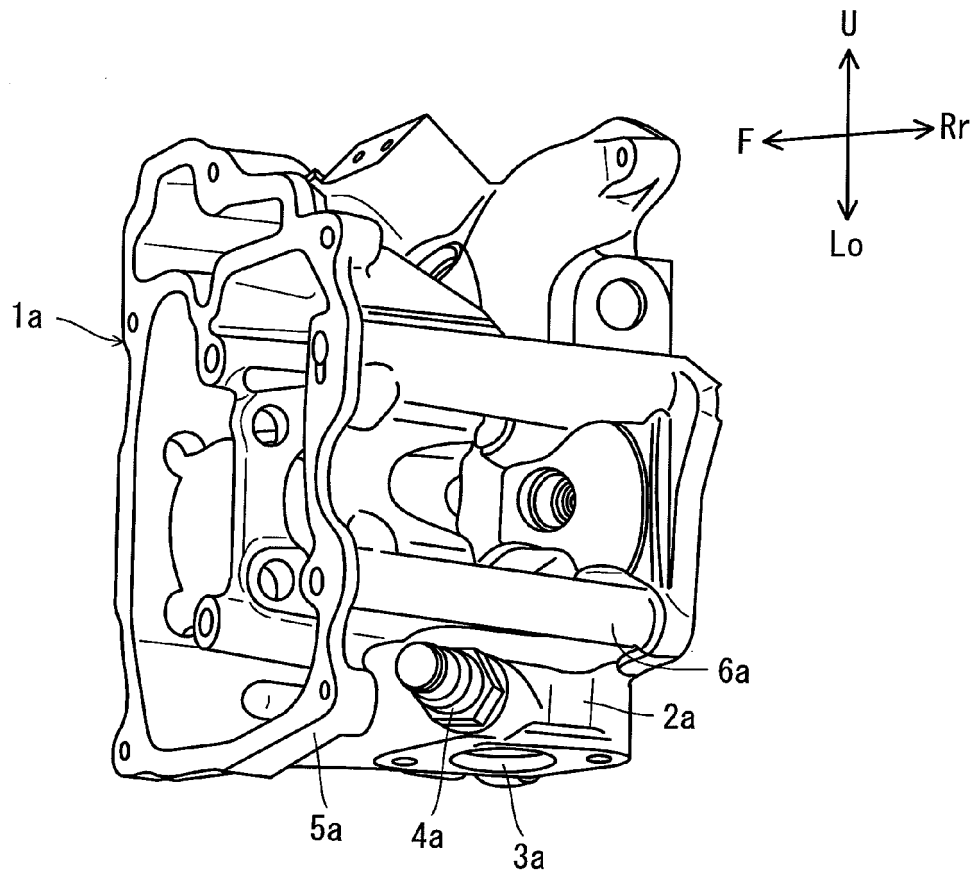


FIG. 19

(a)



(b)

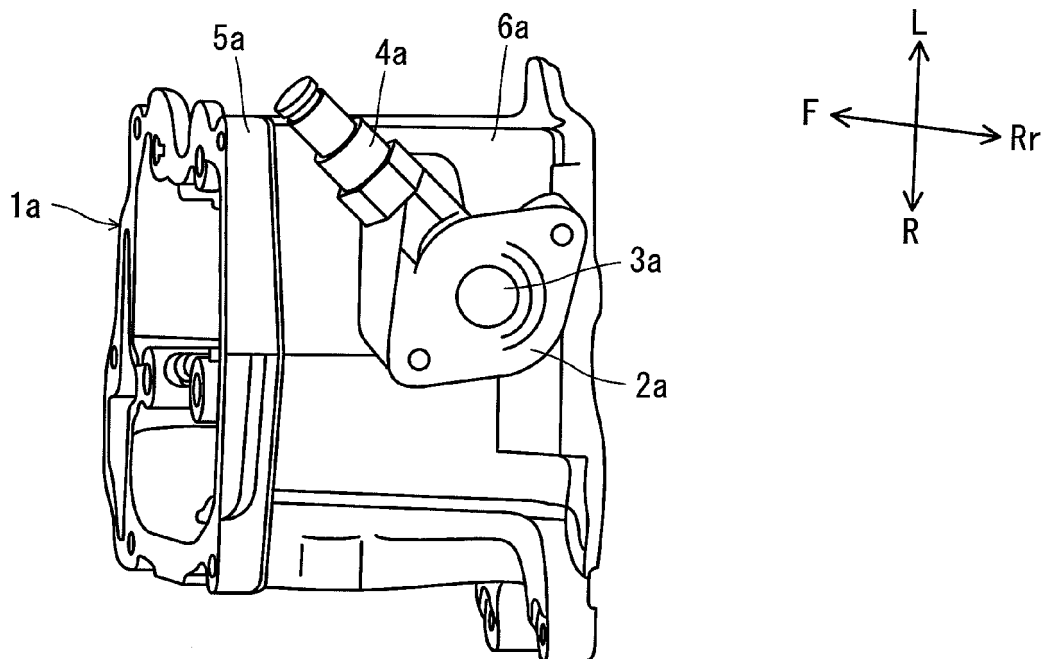
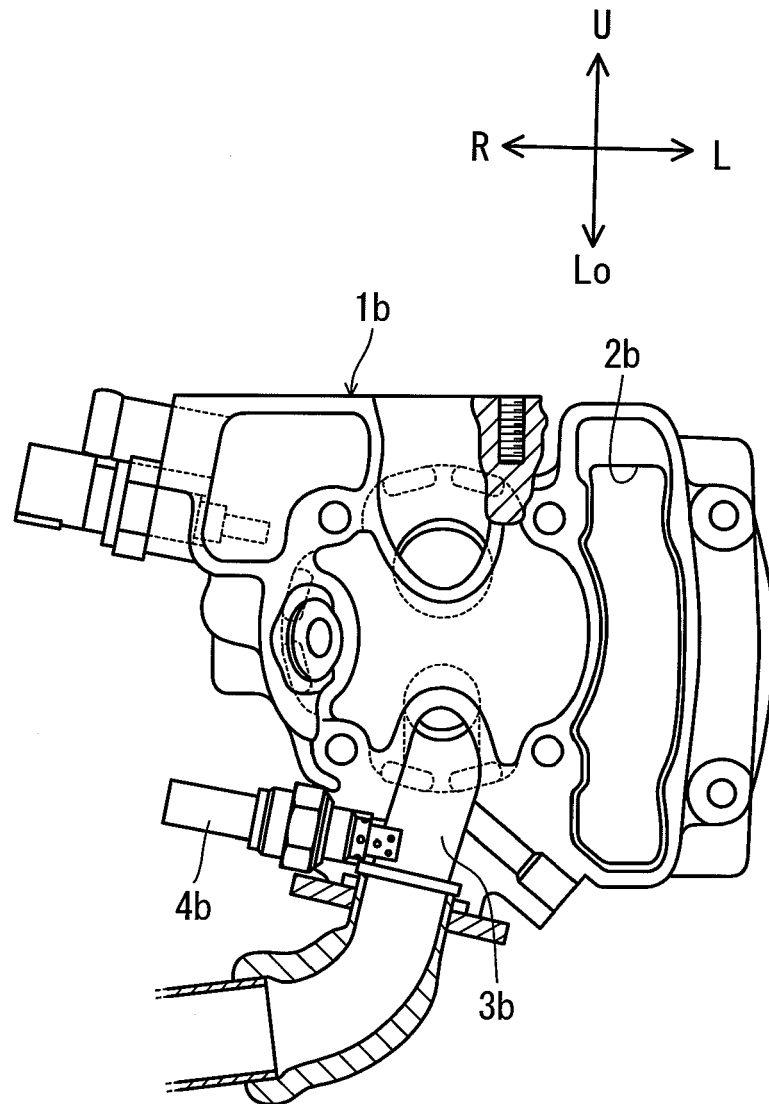


FIG. 20





EUROPEAN SEARCH REPORT

Application Number
EP 10 17 3564

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